Chapter 2

Drainage
Design Standards and Policies
Revised December 1999

Chapter 2, Drainage, contains supplemental information to Chapter 37 of the Scottsdale Revised Code, otherwise known as the Floodplain and Drainage Ordinance. This chapter also describes the City's policies regarding hydrologic analysis procedures to be used in the City of Scottsdale for the planning and design of drainage and flood control facilities and the preparation of accompanying drainage reports. Furthermore, Chapter 2 contains clarifications or modifications to the design criteria and guidance contained in the current Drainage Design Manual for Maricopa County, Volume II Hydraulics.

Section 2.1

POLICIES
DESIGN STANDARDS AND POLICIES
REVISED DECEMBER 1999

CHAPTER 2
DRAINAGE

POLICIES

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SECTION 2.1
POLICIES

2-101 GENERAL

The policies contained herein were written to supplement Chapter 37 of the Scottsdale Revised Code (Code)(Code 1972, §5-611; Ord. No. 1993, 2/29/1988), otherwise known as the Floodplain and Drainage Ordinance. The information included in the sections to follow is intended to serve as a guide, to assist in the implementation of the requirements of the ordinance. These policies must be followed and will be enforced as written unless adequate documentation is submitted to and approved by the city's Floodplain Administrator. The documentation must demonstrate that the intent and requirements of the ordinance will still be met. A copy of the Floodplain and Drainage Ordinance (Drainage Ordinance) is included as Appendix A of this section.

A. Definitions

Unless specifically defined in Section 37-17 of the Drainage Ordinance or stated below, words or phrases used in this article shall be interpreted as the meaning they have in common usage and that gives this article its most reasonable application. The definitions in Arizona Revised Statutes Section 48-3601shall also apply.

50 cubic feet per second (c.f.s.) capacity means the active stream channel can contain a 50 c.f.s. flow within its cross section, as measured from top of bank, or bankfull. Figure 2.1-1 illustrates the cross section of the active stream channel in relation to the 100-year floodplain.

The 100-Year Flood is a flood with a one percent chance of being equaled or exceeded in any given year. Throughout the United States, the standard for floodplain management is protection from flooding up to and including the 100-year flood event.

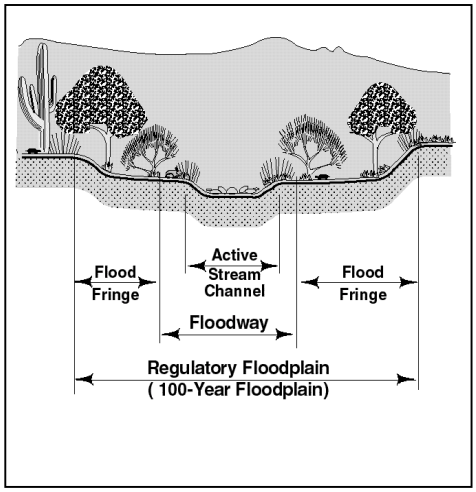

Figure 2.1-1. "Capacity" is Defined as the Bankfull of the Active Stream Channel

In hydrology the 100-year flood is determined statistically from long term records of streamflow or rainfall data. The availability of useful streamflow data for estimating the 100-year flood in most parts of Arizona is very limited. Therefore, the value is generally estimated from rainfall records. Statistical methods are used to predict the 100-year rainfall amount that is then input into hydrologic watershed models. The hydrologic model then predicts the peak rates of runoff for that amount of rainfall. This approach assumes that the 100-year rainfall produces a 100-year flood and all assumptions in the model are correct and that they remain constant over time.

Inherent in the statistical estimating procedure is that as longer periods of record become available and are added to the database the estimated size or frequency of a specific flood can change. The often-heard comment that "two or three 100-year storms occurred last year" is actually possible because natural events in the desert are unpredictable and because statistics can change with one or two additional flood events added to the database. Rainfall and runoff events are infrequent and highly variable in the desert and, therefore, much more difficult to measure and predict than in the more humid regions of the country.

Adjacent Grade means the elevation of the ground, sidewalk, patio, deck support, or basement entryway immediately next to the structure*.(FEMA Form 81-31, May 93)*

Floodway means a part of the floodplain which, to facilitate the passage of floodwater, is kept clear of encumbrances (USGS WSP 1541-A, 1960). The channel of a river or stream and those parts of the flood plains adjoining the channel, which are reasonably required to carry and discharge the floodwater or flood-flow of any river or stream (Erbe and Flores, 1957). The channel of a river and the adjacent floodplain that must be reserved in an unobstructed condition in order to discharge the base flood without increasing flood levels by more than one foot (FEMA FIA-2, 2/1990).

2-102 GENERAL DRAINAGE POLICIES

A. Drainage Easements
Continuous drainage easements are essential to the protection and proper operation and maintenance of wash corridors and floodplains.

1. Acquisition
Drainage easements should be identified and dedicated to the city as early as possible in the development process. Per ordinance, within the Environmentally Sensitive Lands (ESL) area of the city, all washes with a 50 c.f.s. or greater capacity must remain in their natural state and their 100-year floodplain dedicated as a drainage easement. In all other areas of the city, a drainage easement must be dedicated to the extent of the 100-year flood for all washes with a 25 c.f.s. or greater capacity. It is also city policy to require a drainage easement for washes with a 100-year discharge of 50 c.f.s or greater.

City staff shall check both existing and proposed drainage easements in the area of the proposed development to avoid discontinuous drainage easements and assure that the developer provides all necessary drainage easement segments at the time each property develops.

Whenever possible, lot lines should end at the edge of the wash floodplain (see Figure 2.1-1). If this isn't possible, lot lines should end at the following locations in

this order of preference: 1) at the edge of the floodway; 2) at the top of the near bank of the active channel; 3) at the centerline of the active channel; or 4) at the top of the opposite bank. Preferably, floodplains should be set aside in common area Tracts or in dedicated drainage easements. Building envelopes can be useful in identifying the limits of construction on individual lots to avoid the disruption of natural flow paths. Building envelopes shall clearly define the limits for the construction of any walls, fences or structures that would obstruct the natural flow of water, and shall be shown on the Grading and Drainage (G&D) Plan.

2. Maintenance
   City policy is that maintenance of drainage facilities is generally the responsibility of the individual property owner or the Homeowners Association upon whose property the facility is located. This is the case even though the facility is located within a drainage easement dedicated to the city. The recorded plat and grading and drainage plan shall specify maintenance responsibility.

3. Release
   The release or modification of a drainage easement is possible but only if one of the following special circumstances can be documented:
   - Upstream flows have been physically cut off or diminished;
   - More detailed topographic mapping and aerial photography has shown the original dedication to be incorrectly located; or
   - The original hydrology was found to be out of date or in error.

   Boundary modifications must meet in a smooth transition, with upstream and downstream boundaries on adjacent properties. When the alteration of a watercourse is proposed, a registered civil engineer in the state of Arizona must certify that the alterations will not increase flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse (Floodplain and Drainage Ordinance, Section 37-41 (a)).

   The *Application to Release Existing Drainage Easement* (see Appendix B for form) must be completed and submitted with the required documentation. After staff review and approval, the city's Development Quality/Compliance Director and Floodplain Administrator must both sign for final approval to modify or abandon an easement.

B. Subdivisions

1. Proposed subdivisions must develop a comprehensive drainage plan that addresses the drainage for the entire project site. Individual lot grading plans shall not alter the approved comprehensive G&D subdivision plan.

2. Lot Layout: Watercourses shall be identified and their floodplains mapped before lot layout begins. Lot lines should end at the edge of a watercourse's 100-year floodplain (see Figure 2.1-1). If this isn't possible, lot lines should end at the following locations in this order of preference: 1) at the edge of the floodway; 2) at the top of the near bank of the active channel; 3) at the centerline of the active channel; or 4) at the top of the opposite bank.

3. Maintenance of common subdivision or neighborhood drainage facilities shall not be made the responsibility of an individual property owner. Drainage facility(s) shall be placed in a common Tract or a dedicated drainage easement. Common drainage

facilities should overlap more than one lot and be located outside the building envelope. Maintenance responsibilities shall be clearly identified on the grading and drainage plan and on the recorded plat.

C. Storm Drains and Natural Washes

1. Within the ESL area, intercepting a natural wash with a capacity of 50 cfs or greater, and directing it into an underground storm sewer system, is prohibited (see City Code, Section 37-42 (14) a.).

2. Intercepting a natural wash and piping it underground is strongly discouraged in any area of the city for any size wash. Most natural washes and constructed channels in Scottsdale transport a significant amount of sediment, trash, and debris. If there is no alternative to the routing of an open channel into a piped system, water should be first routed into a sediment or debris basin. Periodic maintenance of the basin will be necessary in order to maintain its effectiveness. Maintenance is generally the responsibility of the homeowner or the HOA, and shall be clearly specified on the final plat and/or noted in the easement dedication.

D. Culverts

1. The culvert invert shall be as close as possible to the natural stream bed. Any culvert having an invert elevation more than six inches below the natural stream profile shall be assumed to have only the waterway opening above the stream bed profile for hydraulic capacity calculations.

2. Private culverts/bridges that carry flows that originate off-site or off-lot, should be designed by a qualified professional. Solutions such as dip crossings or free span bridges that do not constrict the wash or channel capacity are preferred. Development and/or proposed improvements shall not hamper the ability of the wash or channel to convey the pre-development or post-development flows, whichever is greater.

E. Open Channels

1. Within ESL areas of the city, natural watercourses of 50 c.f.s. capacity or greater are intended to be maintained in their natural state. (See Section 2-107 for more information.) In all areas of the city, diversions of natural washes or changes in a channel's profile should be avoided whenever possible.

2. No person in the city shall either obstruct or reduce the capacity of a watercourse (Section 37-44). Construction of any kind in a dedicated drainage easement requires a City Encroachment Permit.

3. Channel lining material shall be inlaid or placed below the design invert (bottom) of the channel. Do not place lining material on top of the designed finished grade of the channel. This may severely reduce and/or eliminate the ability of a channel to convey flow, causing ponding and backwater problems on streets and adjacent properties. See Figure 2.1-2 below to see how to correctly line a channel.

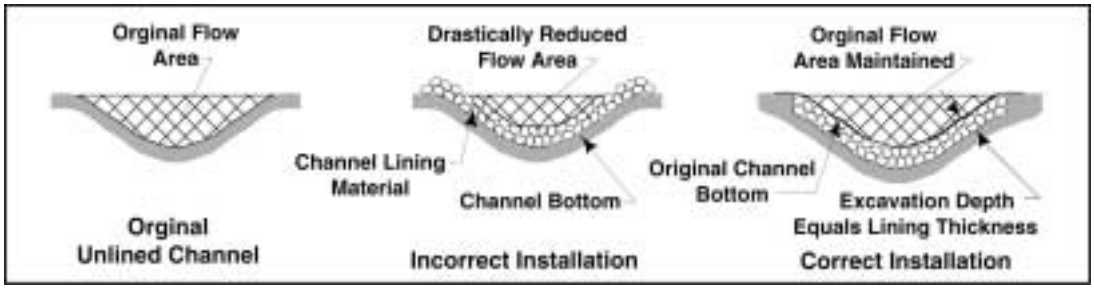

Figure 2.1-2. How To Correctly Line a Channel

4. The channel surface material (roughness coefficient), cross sectional area, or alignment shall not be changed without a plan revision and re-approval by city Staff.

5. When only lining the channel sides or banks, lining material must extend down below the channel invert to the estimated scour depth.

6. Extending lot lines or building envelopes across a natural wash or its floodplain or a drainage easement should be avoided whenever possible. The wash area and floodplain or drainage channel should be dedicated in a separate common area tract and dedicated as a drainage easement.

7. Channels shall not be designed or located within walled in back yards that go from yard to yard under or through walls. Wall openings commonly catch debris, clog, and block or divert flow and homeowners often block off or plug these openings. These channels are practically impossible to inspect or access for maintenance.

8. Walls, fences and other permanent structures should not be located within a designated drainage easement, a watercourse or its floodplain.

F. NPDES

Since October 1, 1992, the National Pollutant Discharge Elimination System (NPDES) General Permit for stormwater discharges required all owners/operators of construction projects disturbing five or more acres to prepare a Storm Water Pollution Prevention Plan (SWPPP) and file a Notice of Intent (NOI). A revision to the law dated October 29, 1999 reduced the five-acre requirement for SWPPPs and NOIs to one acre or more. The city of Scottsdale received its Municipal Separate Storm Sewer System (MS4) NPDES permit (number AZS000020) on August 26, 1999 and is required to have the opportunity to review all SWPPPs and NOIs. The NOI must be sent to the United States Environmental Protection Agency with a copy of the SWPPP and NOI to the city of Scottsdale 72 hours before construction begins. (The city must have evidence of this permit before a development permit will be issued). The goal of this NPDES storm water permit for construction activities is to control pollutants in storm water discharges to the maximum extent practicable by reducing erosion potential, minimizing sedimentation, and eliminating non-stormwater discharges from construction sites.

2-103 DOWNTOWN DRAINAGE POLICY

This section describes drainage policies specific to Downtown Scottsdale. Downtown Scottsdale refers to the study area defined by the City of Scottsdale Downtown Infrastructure Master Plan (DIMP) prepared by Boyle Engineering Corporation in December of 1986, otherwise referred to as the DIMP Report.

A. Definitions
The definitions contained below are applicable to this section only.

Lateral refers to that part of the stormdrain system that collects surface runoff and transmits it to the Infrastructure System.

DIMP Report refers to the City of Scottsdale Downtown Infrastructure Master Plan which is the planning guide used to determine the Baseline Runoff rate that the subject property may contribute to the Infrastructure System (System) without additional cost to the Owner.

Property Owner or Owner refers to actual owner or the person or persons who have a financial interest in the subject property.

Infrastructure System or System refers to the main trunk line of the stormdrain system that transmits the runoff to the point of outfall (i.e., the Indian School Road Stormdrain).

Proposed Intensity refers to the percentage of impervious area proposed for the subject property.

DIMP Report Intensity refers to the percentage of impervious area used in the DIMP Report for the subject property.

Proposed Runoff refers to the runoff calculated using the Proposed Intensity.

Baseline Runoff refers to the runoff calculated using the DIMP Report Intensity.

Excess Runoff is the Proposed Runoff, less the Baseline Runoff. (If the Proposed Runoff is less than the Baseline Runoff, then the Excess Runoff shall be zero.)

B. Requirements
Development proposed in Downtown Scottsdale shall plan to accommodate drainage by meeting the following policies:

1. The Owner shall be responsible for the cost or installation of the Lateral(s) necessary to transmit runoff from the subject site. If the capacity of the Lateral must be increased to accommodate runoff from other properties, then the owner shall contribute a pro-rata share of the cost of the Lateral. This pro-rated cost shall be determined by the ratio of the Proposed Runoff divided by the total capacity of the Lateral. All Laterals shall be designed and constructed in accordance with current city of Scottsdale standards.

2. The release of excess runoff from the subject property will require that the Owner participate in the cost of the System. This shall be a pro-rata cost participation, and shall be based on the ratio of the excess runoff divided by the capacity of the System. This adjusted ratio shall apply to the costs of the System from the point at which the excess runoff enters the System to the outfall point.

3. If the capacity of the System must be increased to accommodate Excess Runoff, the cost participation ratio shall be refigured using the cost of the larger system in the calculation.

2-104 ALLUVIAL FAN DEVELOPMENT POLICY

A. Introduction

Over fourteen square miles of land north of the Central Arizona Project (CAP) Canal falls within designated special flood hazard areas. These areas were mapped by the Federal Emergency Management Agency (FEMA) and identified as alluvial fan flood hazard areas. This designation is identified by the symbol “AO” on the Flood Insurance Rate Maps (FIRMs). In addition to this mapped area, there are several other large, unmapped areas in north Scottsdale that are also subject to similar alluvial fan flood hazards. Since it is essential that the special requirements which must be met to develop on an alluvial fan are clearly understood and followed, the policies in this section are meant to clarify these special requirements and important development issues.

Developing on an alluvial fan must be carefully planned, designed and constructed in accordance with FEMA and COS regulations so that the hazards inherent in this practice can be mitigated or eliminated. These hazards are associated with the following flow characteristics found on alluvial fans:

- Flashflooding and large peak discharges,
- Transport of debris (i.e., rocks, branches, logs, weeds, trash),
- Erosion and scour,
- Transport and deposition of large sediment loads,
- Steep slopes and shallow high velocity flows,
- Unpredictable distribution of flow, and the potential relocation of the flow paths anywhere on the fan (the characteristic that makes it alluvial fan type flooding).

There are two primary concerns in the planning and design of any development on an alluvial fan. The first concern is the safety and protection of the residents and property on the fan area. The second concern involves any adverse effects to adjacent property owners, which could be created, either upstream or downstream, by improper development on the fan.

B. Development Requirements

The following information regarding development on alluvial fans is based on the city's Floodplain and Drainage Ordinance, common drainage law, FEMA rules and regulations and the city's Desert Greenbelt Project. This section does not necessarily include all of the applicable Federal, State or local laws or regulations. None of the requirements mentioned here eliminates the need to comply with any laws or regulations not specifically mentioned herein. Following these requirements is also not a guarantee against flooding. Floods larger than the design flood addressed in this policy can and will occur from time to time.

In order to develop in this special flood hazard area one of two approaches can be used. Method 1 involves developing in the mapped AO Zone flood hazard area and leaving the FEMA designation unchanged. This is possible if specific flood protection measures required by FEMA are incorporated into the design of the structure or development, however, flood insurance is still required. Method 2 involves removing the entire property from the AO Zone. This requires major structural flood control measures that must meet rigorous FEMA design requirements and an actual map revision must be obtained from FEMA. This would remove the AO Zone designation entirely and eliminate the need for flood insurance and the specific development requirements listed below under Method 1.

The following sections include detailed explanations and requirements of each of these methods.

1. Method 1 - Developing Without a Map Revision
   This method for developing in an AO Zone is a reasonable approach for low density developments, small properties and individual residences. It allows single lot owners to develop their property without constructing major, structural, flood control measures. This method does not require approval from FEMA, however, it does require review and approval by the city for compliance with FEMA requirements. Under this approach, homeowners are still required to buy flood insurance if they have a mortgage. The requirements are listed below.

   a. Proposed building sites (single family residence or subdivision) must be reasonably safe from runoff produced by the 100-year storm.

   b. Residential structures shall have the lowest floor (including basement or sunken living room) elevated above the highest adjacent grade at least as high as the depth number specified in feet on the FIRM. If no depth is specified on the FIRM a minimum of two feet above the highest adjacent grade is required.

   c. Site design and grading shall include adequate drainage paths around structures on slopes to guide floodwaters away from proposed structures. Structures should not be placed in low spots or block active channels or flow paths on the fan.

   d. The proposed development must address the impact(s) the project will have on flood hazards in the flood hazard area (other areas of the fan), as well as adjacent or downstream areas beyond the mapped AO Zone.

   e. Any property located below an alluvial fan apex, that has not been structurally contained, must protect its upstream perimeter with structural flood control measures. As a minimum, these measures shall be designed to withstand the entire flow quantities originating from the apex, plus any tributary flows, based on existing watershed conditions. This criterion assumes that runoff from the upstream watershed will not increase in the future.

   f. Flow quantities used to design the perimeter flood control measures may be adjusted if it can be demonstrated by sound engineering analyses that the actual quantities that could reach the perimeter are different from those at the apex. City drainage planning staff guidance and approval must be obtained if less than the full apex flow is used.

2. Method 2 - Removing the Property from the AO Zone
   The removal of any property from the AO Zone requires obtaining a map revision from FEMA. According to FEMA, the only basis for securing a map revision requires the construction of "major, structural, flood control measures." The city's proposed Desert Greenbelt Project (DGBP) Channels is an example of a major, structural, flood control measure, which is being planned and designed to meet FEMA's requirements. The design and construction must be supported by sound engineering methods that demonstrate how the measures will effectively eliminate the alluvial fan flood hazards. Map Revisions based on fill only are not accepted by FEMA on alluvial fans.

The main difficulties associated with this method are that major, structural, flood control measures take years to plan, design, fund, review, permit, and construct. They are generally only achieved via large regional solutions that are very expensive and encompass multiple land owners and agencies. The benefit of a Map Revision is that the flood hazard is completely removed and property owners will no longer be required to purchase flood insurance once the property is removed the from the AO Zone.

In order to obtain a Map Revision, the following requirements listed below, must be met:

a. FEMA requires a thorough engineering analysis, which quantifies the peak discharge, volume of water, debris characteristics and sediment loads produced by the runoff from a 100-year storm. This must be done at the alluvial fan apex under current and potential adverse (i.e., fully developed) watershed conditions. It must be shown that the proposed flood control measures will effectively eliminate alluvial fan flood hazards from the fan area.

b. The minimum FEMA freeboard requirement for flood control structures on an alluvial fan is three to four feet, depending on the proximity to bridges, etc. A lesser freeboard is possible; however, FEMA will not accept a freeboard of less than two feet. The city will require an engineering analysis that demonstrates to FEMA's satisfaction, that adequate freeboard is provided.

c. FEMA requires the city of Scottsdale to assume ultimate responsibility for all operation and maintenance activities for major, structural, flood control measures. The actual activities could be accomplished in a variety of ways, including utility or improvement districts, delegation to homeowner's associations or contracting through the Flood Control District of Maricopa County (FCDMC), all of which require legal agreements adopted by City Council.

d. The proposed development must address the impact(s) the project will have on flood hazards in the flood hazard area (other areas of the fan), as well as adjacent or downstream areas.

C. Property Adjacent to City's Proposed Desert Greenbelt Channels
A parcel of property which contains any portion of one of the proposed Desert Greenbelt (DGB) channels, that develops prior to the construction of the greenbelt, shall, as part of their development costs, construct or contribute funds to that portion of the DGB.

2-105 STORMWATER STORAGE POLICY

A. Introduction
The current city of Scottsdale's stormwater storage requirements are contained in Section 42-(12) in Chapter 37, “Floodways and Floodplains" of the Scottsdale Revised Code, referred to as the city's Floodplain and Drainage Ordinance.

The requirement to store stormwater runoff has been in place since February 29, 1988, with the adoption of Ordinance No. 1993. The city continues to uphold its obligation and responsibility to its residents and neighboring communities by maintaining the current stormwater storage requirements. These requirements are derived from the Uniform Drainage Policies and Standards (Resolution FCD 87-7) developed for use throughout

Maricopa County. The Maricopa County Board of Supervisors approved this Resolution on April 20, 1987.

This section contains the city's policy regarding stormwater storage requirements. Stormwater storage facilities are normally detention facilities and in rare cases, with appropriate city approval, they may be retention facilities.
Section 2.3 of this Chapter contains policies for the actual design of storage facilities. The following policy statements are intended to clarify and assist in the implementation of the ordinance requirement.

B. Storage Requirements

1. "As a minimum, all development will make provisions to store runoff from rainfall events up to and including the one-hundred-year two-hour duration event."

2. The storage requirement applies to the total disturbed area within the development to the property lines including streets, alleys, easements and rights-of-way. The disturbed area includes any man-made change, such as, but not limited to construction, mining, excavation, filling, grading, or paving. The volume of storage provided onsite must equal the total runoff volume generated from all the disturbed area within the site for fully developed conditions.

3. The storage requirement is not applicable to undisturbed, natural areas. Any portion of the site that remains in its natural state, may be excluded from the amount of land area used in the storage requirement calculation.

4. Pre-development versus post development comparisons is not applicable in computing required storage volumes, the standard formula in Chap. 2.2, Sec. 2-204 must be used.

5. Stormwater Storage Volume Certification: The property owner will provide the city with certified as-built dimensions of the basins and the actual volume of storage provided. This must be based on "as built" topographic surveys made by either a civil engineer or land surveyor who is registered to practice in the state of Arizona. These as-built volumes must reflect permanent finished landscaping in place. The volumes shall be certified by the Design Engineer whether the volume provided meets or exceeds the required design volumes per COS Ordinance and the approved Drainage Plan. The volume of storage provided must equal or exceed the approved design volumes before the city will issue Letters of Acceptance for maintenance of any public facilities.

C. Storage Facilities

1. Offsite washes should not be routed into or through onsite stormwater storage basins. Basins located on-stream interrupt the natural flow regime of the wash and can create a continual debris and sediment maintenance problem.

2. Storage basins should whenever possible be designed with a positive gravity drain system. See Chapter 2.3 Sec. 2-308 D. for other acceptable methods of draining. Dry wells may only be used as a last resort (see City Code Section 37-42 (12) a.).

3. All storage basins must have an emergency spillway that will direct any overflow safely into a recognized watercourse.

4. Above ground storage basins contained by an earth fill dam or levee are prohibited unless the fill is part of an approved street or road design.

5. Storage facilities on individual residential lots are generally prohibited and only allowed in specific special circumstances that must be approved in advance by city staff.

   Onlot storage will only be permitted when unobstructed access from a public rights-of-way can be provided. Homeowners traditionally fill the basins in and the runoff often ends up in their house, pool, in a neighbor's property, or in a city alley or street.

6. Storage water shall be designed to drain to a recognized watercourse. Water may not be discharged onto a city street, gutter or alley. Specific special prior staff approval would be required to discharge water into a street, alley, or gutter.

7. All storage facilities shall be designed such that the stored runoff shall be discharged completely from the facility within 36 hours following the storm event. This is a city Ordinance requirement related to County Health Department Standards.

8. Drain time should not be less than 24 hours to ensure the effectiveness of the basin. Discharge from the basin can be regulated with an orifice plate over the entrance of the outlet pipe, as long as the outlet pipe meets the minimum size pipe requirements.

2-106 WAIVER OF STORMWATER STORAGE REQUIREMENTS

A. Introduction

Under the Floodplain and Drainage Ordinance, stormwater storage requirements may be waived if a project meets one or more of the specific criteria listed in the Code. Meeting the waiver criteria, however, does not necessarily mean a waiver will be automatically granted. City staff will process the request and if it is in the best interest of the public, the waiver will be granted. It is not appropriate to automatically assume stormwater storage is not necessary because a project area is small relative to the entire watershed; or because a project is at the very downstream end of the watershed. The cumulative effects on the entire upstream and downstream watershed shall be considered. It is a common misconception that a small project is insignificant in a large drainage area. Typically this is only valid if the remainder of the watershed is already fully developed, and if downstream receiving channels and or storage facilities have adequate additional capacity. If not, the cumulative effects of waiving retention on many small individual projects within the same watershed can result in major downstream impacts.

B. Waiver Requirements

1. All onsite storage requirements may be waived if a site can drain directly into an existing regional drainage system designed and constructed to contain or convey the additional runoff.

2. Most often, however, a development must, as a minimum, store the runoff volume necessary to maintain pre-development flow conditions.

3. A wavier approval of any kind is not authorization by the city for the developer to increase runoff or change drainage characteristics to the detriment of any other property owner.

4. A waiver approval does not relieve the developer of liability if the project causes increased flood damage on any other property.

C. Waiver Process

1. To obtain a waiver, the developer must submit a Request for Stormwater Storage Waiver Form with completed In-Lieu Fee Calculations to the city for review. See Appendix D for the *Request for Stormwater Storage Waiver Form* which includes the *In-Lieu Fee Calculations sheet*.

2. After staff's review is complete, the applicant will receive a copy of the processed Waiver Form, which will indicate: additional information needed, approval, or denial of the request.

3. Project Review will not accept final improvement plans for review without a copy of the approved Waiver Form if the project design is based on providing anything less than the full ordinance storage requirements.

4. The completed Waiver Form with the In-Lieu Fee Calculations shall be included in the drainage report. Approved copies of both shall be attached to the final approved Drainage Report.

D. In-Lieu Fees
If storage is waived, the Drainage Ordinance requires the development to contribute to the cost of drainage works. In-lieu contributions will be applied to drainage improvements throughout the city. The developer shall estimate the in-lieu contribution and submit it to the city for review and approval.

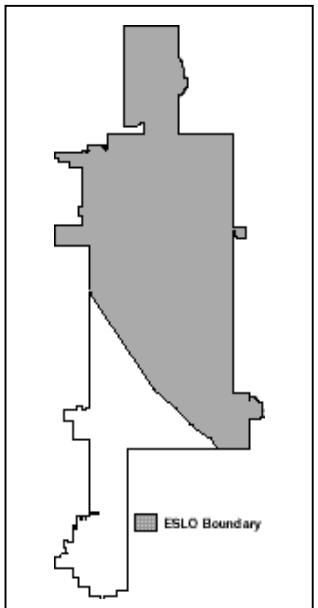

Figure 2.1-3.
ESLO Area

2-107 50 C.F.S. CAPACITY WASHES WITHIN ESL AREAS

A. Introduction
The Floodplain and Drainage Ordinance identifies special considerations within the Environmentally Sensitive Lands (ESL) areas. In particular, it requires that washes within the ESL area (see Figure 2.1-3) that have a 50 cubic feet per second (c.f.s.) or greater capacity be maintained in their natural state and their 100-year floodplains be dedicated to the city as drainage and flood control easements. Preserving these continuous drainage corridors will help to safely convey floodwaters and stormwater runoff, protect city residents and their property, reduce costs for solving drainage problems, and maintain the natural and beneficial values of floodplains.

B. Requirements for Projects within the ESL Area

1. Identify washes on the project site with a capacity of 50 c.f.s. or greater and map their 100-year floodplains. (See Section 2-101 A. for the definition of a 50 c.f.s. capacity wash and Figure 2.1-1 for a wash cross section.)
2. Maintain washes with a capacity of 50 c.f.s. or greater in their natural state.
3. Dedicate a drainage and flood control easement to the city to the limits of inundation for the100-year flood.

C. City Maps of 100-Year Floodplains of 50 c.f.s. Washes

1. City staff is in the process of identifying these washes and mapping their 100-year floodplains as a layer within the city's GIS–based Land Information System (LIS). Check with city staff to see if the 100-year floodplains have been mapped for the area you are interested in.

2. The city mapped floodplain boundaries in the LIS are based on approximate methods and represent an estimate of the limits of inundation.

D. Detailed Mapping of 50 c.f.s. Floodplains
The developer may choose to have the floodplains analyzed in more detail, using HEC-2 or HEC-RAS. Floodplain mapping refinements must be done by a registered civil engineer and submitted to the city's Floodplain Administrator for review and approval.

E. Maintaining Washes in Natural State
Roads are permitted to cross washes, however, approval is required from the Project Review Director if disturbance of the natural channel extends beyond the right-of-way.

2-108 SECTION 404 OF THE CLEAN WATER ACT

The Code of Federal Regulations requires that if a community wants to participate in the national flood insurance program, it has to assure that developments within its boundaries comply with Section 404 of the federal Clean Water Act.

A. Regulated Activities
Section 404 is administered by the U.S. Army Corps of Engineers and regulates the discharge of dredged or fill material into a wetland, lake, (including dry lakes), river, stream (including intermittent streams, ephemeral washes, and arroyos), or other waters of the United States. Activities that result in a discharge to a watercourse, such as fill for construction activities, most likely will require a Section 404 permit. Utility and road crossings, bridges, bank protection, sand and gravel mining, and fill associated with residential and commercial development are typical activities which require Section 404 permits.

B. Compliance Requirements
The city of Scottsdale requires the completion of the *City of Scottsdale Section 404 Certification Form* as assurance that a development project complies with Section 404 of the federal Clean Water Act. Before the city may issue development permits for a project, this form must be completed and submitted with improvement plans to Project Review staff. Developers are advised to apply to the Corps as early as possible for a Section 404 permit and allow for the necessary processing time to prevent delays in obtaining development permits from the city of Scottsdale. The *City of Scottsdale Section 404 Certification Form* is included as *Appendix C* of this section.

APPENDIX A

Chapter 37 of Scottsdale Revised Code, Floodplain and Drainage Ordinance

(Check the city's Ordinance Webpage for the most current version of the Floodplain and Drainage Ordinance and download a copy from there.)

Chapter 37 FLOODWAYS AND FLOODPLAINS*

***Charter reference(s)--**General power of city over floodways, etc., art. 1, § 3.

Cross reference(s)--Buildings and building regulations, Ch. 31; planning and development, Ch. 46; subdivisions, Ch. 48; basic zoning ordinance, App. B.

ARTICLE I. IN GENERAL

Secs. 37-1--37-15. Reserved.

ARTICLE II. FLOODPLAIN DEVELOPMENTS

DIVISION 1. GENERALLY

Sec. 37-16. Purpose; title.

(a) It is the purpose of this article to establish requirements and regulations pertaining to the use and development of land in the city which will minimize the occurrence of losses, hazards and conditions adversely affecting the public health, safety and general welfare which might result from flooding caused by the surface runoff of rainfall.

(b) This article may be referred to as "the floodplain and drainage ordinance."

(Code 1972, § 5-611; Ord. No. 1993, 2-29-88)

Sec. 37-17. Definitions.

Unless specifically defined below, words or phrases used in this article shall be interpreted so as to give them the meaning they have in common usage and to give this article its most reasonable application. The definitions in Arizona Revised Statutes section 48-3601 shall apply.

Appeal means a request for a review of the floodplain administrator's interpretation of any provision of this article or a request for a variance.

Area of shallow flooding means a designated AO and/or AH zone on the flood insurance rate map (FIRM). The base flood depths range from one (1) to three (3) feet, a clearly defined channel does not exist, the path of flooding is unpredictable and indeterminate, and velocity flow may be evident.

Base flood means the flood having a one-percent chance of being equalled or exceeded in any given year. This is also called a one-hundred-year flood.

Base flood water surface elevation means the following:

(1) In regulatory floodways and special flood hazard areas as shown on the firm or on other maps adopted by the floodplain board, the base flood water surface elevations shall be those elevations shown on the FIRM or adopted maps. For the floodways; however, when the city floodplain administrator determines that more accurate base flood water surface elevation data is available, than the data shown on the FIRM's, the more accurate data shall be used.

(2) In special flood hazard areas adopted by the floodplain board, the base flood water surface elevations shall be those elevations established in accordance with paragraph 37-18(c)(2).

(3) In a regulatory floodway not shown on the FIRM, the base flood water surface elevations shall be those elevations established in accordance with paragraph 37-18(c)(2).

(4) For those areas of the city which are not within a regulatory floodway or a special flood hazard area, the base flood water surface elevations shall be those which are established by a drainage report submitted in accordance with the criteria contained herein.

Basement means the lowest level or story of a structure which has its floor subgrade on all sides.
Breakaway wall means a wall that is not part of the structural support of the foundation and is intended through its design and construction to collapse under specific lateral loading forces, without causing damage to the elevated portion of the building support or foundation system.
Construction means new construction of or substantial improvements to a structure.
Critical feature means an integral and readily identifiable part of a flood protection system without which the flood protection provided by the entire system would be compromised.
Depressed floor area is a portion of the first floor of a residential structure, such as a sunken living room or a conversation pit, which is lower than the surrounding floor area, and which has no floor-level access to areas outside the structure. (This is not a multilevel first floor which is stepped to conform to site slope conditions).
Detention basin means a hydraulic structure similar to a reservoir that intercepts and retards or detains storm water and is specifically designed to attenuate or dampen peak discharge rates.
Development means any man-made change to improved or unimproved real estate, including, but not limited to, construction, mining, excavation, filling, grading, or paving.
Environmentally sensitive lands means environmentally sensitive lands as defined in Ordinance Numbers 1881 and 1883.*

***Editor's note--**Ordinance No. 1881 is included in this Code as Ch. 46, Art. III, Div. 1, §§ 46-61--46-65; Ord. No. 1883 is included as Ch. 46, Art. III, Div. 2, §§ 46-73--46-77.

Financial assistance means any form of loan, grant, guarantee, insurance, payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect federal assistance, other than general or special revenue sharing or formula grants made to states.
Flood or *flooding* means a general and temporary condition of partial or complete inundation of normally dry land areas from:

(1) The overflow of floodwaters;
(2) The unusual and rapid accumulation or runoff of surface waters from any source, and/or;
(3) The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood, or by some similarly unusual and unforeseeable event which results in flooding as defined in this definition.

Flood boundary floodway map means the official map on which the Federal Insurance Administration has delineated both the areas of flood hazard and the floodway.
Flood hazard boundary map (FHBM) means an official map of a community issued by the Federal Emergency Management Agency where the boundaries of the flood, mudslide (i.e. mudflow) and related erosion areas having special hazards have been designated as zones A, M, and/or E.
Flood insurance rate map (FIRM) means the official map on which the Federal Insurance Administration has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.
Flood hazard zones A, AE, AO, AH, A1-30 and, A99 are the areas shown on a FIRM which the Federal Emergency Management Agency has determined will be inundated during a one-hundred-year flood. These areas are called, collectively, "special flood hazard areas."
Flood hazard zone B or X is an area shown on a FIRM which is an area of moderate flood hazards.
Flood hazard zone C or X is an area shown on a FIRM which is an area of minimal hazards.
Flood hazard zone D is an area shown on a FIRM which has undetermined but possible flooding hazards.

Flood hazard zone E is an area of special flood-related erosion hazards.
Floodplain administrator means the city manager or designee who is authorized by this article to administer its provisions.
Floodplain or *Flood-prone area* means any land area susceptible to being inundated by water from any source (see definition of "flooding").
Floodplain board means the city council of the city at such times as they are engaged in the enforcement of this article.
Floodproofing or *floodprotection* means any combination of structural and nonstructural additions, changes, or adjustments to structures, including utility and sanitary facilities, which would preclude the entry of water. The structure must be watertight, with walls which are substantially impermeable to the passage of water. Structural components shall have the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy.
Floodway is the channel of a river or other watercourse and the adjacent land areas necessary in order to discharge the one-hundred-year flood without cumulatively increasing the water surface elevation.
Grading is any excavation or filling of land or combination thereof.
Lowest floor means the lowest floor of the lowest enclosed area (including basement). An unfinished or flood-resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a basement area is not considered a building's lowest floor; provided, that such enclosure is not built so as to render the structure in violation of the applicable non-elevation design requirements of this article.
Manufactured home means a structure, transportable in one (1) or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. For floodplain management purposes the term "manufactured home" also includes park trailers, travel trailers and other similar vehicles placed on a site for more than one hundred eighty (180) consecutive days.
Manufactured home park (subdivision) means a parcel or contiguous parcels of land which have been divided into two (2) or more lots for rent or sale and the placement of mobile homes.
Natural areas shall mean those areas within environmentally sensitive areas which are required to be retained in a natural state, including areas stipulated as such through the zoning process. Special conditions relating to environmentally sensitive lands will apply to such "natural areas."
Regulatory base flood elevation means an elevation one (1) foot above the "base flood water surface elevation."
Regulatory floodway means the channel of a wash or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without raising the water surface elevation.
Residential structure means a place of residence and may be a single-family or multifamily dwelling.
Retention basin means an hydraulic structure similar to a reservoir that intercepts and stores stormwater and is specifically designed to be drained to the underground or to be emptied by evaporation to the atmosphere.
Special flood hazard area means an area having flood and/or flood related erosion hazards as shown on a FHBM or FIRM as zone A, AO, A1-30, AE, A99, AH, or E, and those areas identified as such by the floodplain administrator, delineated in accordance with paragraph 37-18 (b) and adopted by the floodplain board.
Start of construction, for purposes of this article only, includes substantial improvement, and means the date the building permit was issued, provided the actual start of construction, repair, reconstruction, placement, or other improvement was within one hundred eighty (180) days of the permit date. The actual start means either the first placement of permanent construction of a structure on a site, such as the pouring of slab or footings, the installation of piles, the construction of columns, or any work beyond the stage of excavation; or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation,

such as clearing, grading and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers, or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure.

Structure means a walled and roofed building or a gas or liquid storage tank that is principally above the ground. This term includes, but is not limited to, houses, commercial buildings, factories, storage buildings, mobile homes, and similar structures.

Substantial improvement means any repair, reconstruction or improvement of a structure, the cost of which equals or exceeds fifty percent of the market value of the structure either before the improvement is started or before the damage occurred, if the structure has been damaged and is being restored. For the purposes of this definition, "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. The term "substantial improvement" does not, however, include any alteration to comply with existing state or local health, sanitary, building, or safety codes or regulations which are solely necessary to assure safe living conditions.

Variance means a grant of relief from some of the requirements of this article which permits construction in a manner that would otherwise be prohibited by this article.

Waste disposal system means any system of disposing of worthless materials and useless by-products, either sanitary or commercial or industrial, except existing single-family septic systems and sanitary sewer pipe lines.

Watercourse means a lake, river, creek, stream, wash, arroyo, channel or other topographic feature on or over which waters flow at least periodically. Watercourses includes specifically designated areas in which substantial flood damage may occur.

(Code 1972, § 5-612; Ord. No. 1993, 2-29-88)

Sec. 37-18. Basis for establishment of special flood hazard areas and regulatory floodways.

(a) The city is a participant in the National Flood Insurance Program (NFIP). The special flood hazard areas and the parts of those areas which are designated as regulatory floodways are identified and delineated by the federal emergency management agency (FEMA) in an engineering report titled "Flood Insurance Study, Scottsdale, Arizona" with accompanying flood insurance rate maps (FIRM's) and flood hazard boundary maps (FHBM's). Such studies and maps are prepared for communities participating in the NFIP. The first study and maps for Scottsdale were dated June 1972, and there have been several revisions. The current flood insurance study and flood insurance rate maps for Scottsdale are on file at the city clerk's office, and they are hereby adopted by reference and declared to be a part of this article.

(b) A special flood hazard area shall be those areas of the city identified on the FIRM's including, but not limited to, zone A, zone A1-30, zone AE, zone AH, zone A99, and zone E; and those areas which have been identified by the floodplain administrator, adopted by the floodplain board, and have been delineated in accordance with Arizona Revised Statutes, sections 48-3609 and 48-3610; and which are compatible with criteria developed by the state director of water resources for defining the extent of flooding and the base flood water surface elevations.

(c) The regulatory floodways shall be:

(1) Those areas of the city identified on the FIRM's as flood hazard zones, including, but not limited to, zone AE, and zone AO.

(2) Those other areas shown on the FIRM and those areas not shown on the FIRM which have been adopted by the floodplain board as special flood hazard areas and require the definition of regulatory floodways.

(d) If a development is proposed on land designated as a special flood hazard area, the development shall:

(1) Be designed and constructed in a manner which complies with the requirements in section 37-41, and in a manner which raises the developed land to an elevation which is at or above the regulatory base floodwater surface elevation;

(2) Upon completion of the grading and flood protection features of the development, the developer shall provide the floodplain administrator as built grading plans and other engineering data prepared and signed by a professional engineer or registered land surveyor, which demonstrates compliance with this ordinance; and

(3) If the development lies within a special flood hazard zone shown on the FIRM, the developer shall provide the floodplain administrator the appropriate engineering data and certification showing that the development no longer lies within a special flood hazard zone. The developer shall also provide to the administrator an application to the Federal Emergency Management Agency requesting a letter of map amendment or letter of map revision. The administrator will forward the application with appropriate recommendations to the federal emergency management agency for action.

(e) The requirements described in paragraph (d)(3) above, of this section do not apply to the construction of:

(1) An individual, single-family residential structure, or

(2) An individual, multifamily residential or nonresidential structure on a parcel of land under one-half acre in size, however, the community development general manager or designee will notify the property owner that appropriate insurance will be required by federally insured lending agencies.

(f) If the requirements in subsection (d), do not apply to a development, the lowest floor elevation requirements described in section 37-42 paragraphs (6) and (7) are applicable.

(Code 1972, § 5-614; Ord. No. 1993, 2-29-88)

Sec. 37-19. Floodplain administrator.

(a) *Designated.* The city manager or designee shall be the floodplain administrator.

(b) *Responsibilities.* It is the responsibility of the floodplain administrator or his authorized representative to do the following:

(1) Review all applications for development permits and insure that the requirements of this article are enforced.

(2) Provide the Federal Emergency Management Agency (FEMA) information needed to update the FIRM's and serve as the city's agent for handling revisions of the FIRM's.

(3) Coordinate the provisions of this article with all other interested and affected political subdivisions, federal and state agencies as required by Arizona Revised Statutes sections 48-3609 and 48-3610, and 44 CFR parts 60.2 (e) and 60.3 (b)(6).

(4) Make interpretations where needed as to the exact location of the flood hazard zone boundaries and, when requested, provide the public with information concerning these interpretations and the content of the FIRM's.

(5) Take action on violations of the regulations in this article.

(6) Submit an annual reports to FEMA as required by 44 CFR parts 59-77 and 60.2 (f), and the coordinating agency for the state concerning the city's management of development in special flood hazard areas.

(7) Review proposed development documents to assure that necessary permits required by section 404 of the Clean Water Act (33 USC 1344) have ben obtained

for such development prior to issuance of any development permits required by the city or state statute.

(8) Notify FEMA of any annexations to the incorporated areas of the city and of any de-annexations.

(9) Maintain the following records and, upon request, provide the public with information concerning the content of these records:

a. A current copy of the FIRM's and of any letters of map amendment or any letters of map revision issued by FEMA for development in the city.

b. Certificates provided by builders pertaining to lowest floor elevations and floodproofing in the special flood hazard areas.

c. Floodplain and drainage management permits.

(10) Administer the processing of requests for a variance from the requirements of this article, maintain records of all actions taken, and report the variances that have been issued in the annual report to FEMA.

(Code 1972, § 5-616; Ord. No. 1993, 2-29-88)

Sec. 37-20. Appeals and variances.

(a) A person may appeal to the floodplain board for a variance or for a judgment on the interpretation of this article. The floodplain board may grant a variance if conditions would not be created by the variance which would result in danger or damage to persons or property and if strict application of the regulations would deprive the property owner of privileges enjoyed by similar property in the floodplain. The following subsections describe the conditions applicable to the granting of a variance.

(b) A variance shall not be granted for property within a regulatory floodway if any increase in the water surface elevation during a base flood discharge would result.

(c) A variance may be granted in conformance with subsections (d), (e) and (f) of this section for new construction and substantial improvements to be erected on a lot of one-half acre or less in size contiguous to and surrounded by lots with existing structures with lowest floors constructed below the base flood level.

(d) A variance shall only be granted upon the determination of the following:

(1) A good and sufficient cause exists.

(2) Failure to grant the variance would result in exceptional hardship to the applicant.

(3) Granting the variance will not allow conditions to be created which result in increased floodwater heights, additional threats to public safety, extraordinary public expense, the creation of nuisances, the causing of fraud or victimization of the public, or conflict with other laws or ordinances.

(e) A variance shall only be granted upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief for the applicant.

(f) The floodplain administrator shall notify the applicant in writing that the following conditions will exist as a result of the variance:

(1) Construction of a lowest floor below the base flood level will result in increased premium rates for flood insurance.

(2) Construction below the base flood level increases risks to life and property.

(g) While the granting of variances generally is limited to a lot size less than one-half acre, deviations from this limit may be considered by the floodplain board; however, as the lot size is increased beyond one-half acre, the technical justifications required for a variance must be more detailed and comprehensive.

(Code 1972, § 5-617; Ord. No. 1993, 2-29-88)

Sec. 37-21. Interpretation.

In the interpretation and application of this article, all provisions shall be:

(1) Considered as minimum requirements;

(2) Liberally construed in favor of the council; and

(3) Deemed neither to limit nor repeal any other powers granted under law.

(Code 1972, § 5-619; Ord. No. 1993, 2-29-88)

Sec. 37-22. Warning and disclaimer of liability.

The degree of flood protection provided by the requirements in this article is considered reasonable for regulatory purposes and is based on scientific and engineering considerations. Floods larger than the base flood can and will occur on rare occasions. Floodwater heights may be increased by manmade or natural causes. This article shall not create liability on the part of the city, any officer or employee thereof, or the federal government for any flood damages that result from reliance on this article or any administrative decision lawfully made thereunder.

(Code 1972, § 5-620; Ord. No. 1993, 2-29-88)

Secs. 37-23--37-40. Reserved.

DIVISION 2. REGULATIONS

Sec. 37-41. Prohibited development.

(a) A development is prohibited if it would create hazards to life or property by increasing the potential for flooding either on the property to be developed or on adjacent property or to any other property. Further: A watercourse may not be altered. Alteration within the meaning of this section includes, but is not limited to, encroachments, fill, new construction, substantial improvements to existing developments, and other construction, within a watercourse, unless professional engineer certifies that the alterations do not increase the flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse.

(b) Waste disposal systems shall not be installed wholly or partially in a floodway and or a regulatory floodway. Replacement of existing systems will be reviewed on an individual basis and may be granted a variance if approved by the Arizona Department of Water Resources.

(Code 1972, § 5-615(A); Ord. No. 1993, 2-29-88)

Sec. 37-42. Development requirements to be met for permit issuance.

Prior to the issuance of a permit by the city for development on private property or for work in the public rights-of-way, the applicant for the permit shall furnish the floodplain administrator and the project review manager information as required to determine that all proposed building sites will be reasonably safe from flooding and sufficient data to enable the city staff to determine that the proposed work is not of such a scope that it would be prohibited in accordance with subparagraphs (1) and (2) of this section. Reports, construction plans, and other data submitted in support of an application for a permit shall comply with the following criteria:

(1) *Drainage reports.* When a drainage report is required, it must be prepared and sealed by a civil engineer registered as a professional engineer in the state and it must be prepared in accordance with the criteria established by the city. The purpose of the report is to analyze the effect that a proposed development would have upon the rainfall runoff in the vicinity of the development, to provide data to insure that the development is designed to be protected from flooding, to provide data to insure that the development is to be designed to minimize flooding and to provide data supporting the design of facilities to be constructed for the management of rainfall runoff. Each drainage report must consider rainfall runoff from storms with a return frequency up to and including a one-hundred-year storm. The complexity of the report depends upon the nature of the development and the site on which the development will occur. A drainage report shall be submitted by an applicant requesting one of the following:

a. Approval of a subdivision plat, condominium, townhouse, or a lot split.

b. A permit for grading, unless the requirement is waived by the floodplain administrator.

c. A permit to construct right-of-way improvements.

d. A permit to construct any structure, except that a report will not be required if the structure is to be a single-family residential structure to be built without a basement outside of a special flood hazard area and to be located at a site which the floodplain administrator has determined will not be in the vicinity of a watercourse in which the flow of rainfall runoff might be hazardous to the structure or its occupants.

(2) *Drainage characteristics.* Rainfall runoff from storms of all return frequencies should enter and depart from property after its development in substantially the same manner as under pre-development conditions. Any proposals to modify drainage characteristics must be fully justified by engineering data which shall demonstrate to the floodplain administrator that hazards to life and property will not be increased by the proposed modifications. As a minimum, drainage and flood control easements will be dedicated to the city to the extent of the estimated one-hundred-year flood for all watercourses having a capacity of twenty-five (25) cubic feet per second or greater, and the development shall be responsible for the maintenance of the watercourse. Exceptions to this regulation will be for environmentally sensitive lands covered under section 37-42 (14) and other areas covered by master drainage plans, council stipulations or other provisions of this article which insure that the standards established by this section are met. Any proposed modification must be compatible with environmentally sensitive lands criteria.

(3) *Street crossings at natural or man-made drainage channels.*

a. The crossing structure requirements listed herein will normally apply; however, the engineer may depart from these requirements if he can demonstrate to the Floodplain Administrator's satisfaction that they are inappropriate because of the type of development or the nature of the terrain or because the requirements violate environmentally sensitive land ordinances. In extreme cases it may be necessary to allow for the entire channel flow to pass over the road.

1. Local and minor collector streets shall have a culvert or bridge which is capable of carrying all of the peak flow of runoff from a ten-year-frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a twenty-five-year-frequency storm beneath the road so that the portion of the flow over the road is no more than six (6) inches deep.

2. Major collector and major or minor arterial streets shall have a culvert or bridge which is capable of carrying all of the peak flow of runoff from a fifty-year-frequency storm beneath the roadway and which is also capable of carrying enough of the peak flow of runoff from a one-hundred-year-frequency storm so that the portion of the flow over the road is no more than six (6) inches deep.

3. Watercourse crossings for roads shall be designed so that all lots and structures within a development will be accessible from the boundary of that development by at least one (1) route during the period of peak flow of runoff from a one-hundred-year-frequency storm. The boundary shall include any adjacent street or streets. Accessibility will be considered to exist if it can be demonstrated by the engineer that at the time of the peak flow the depth of flow over the road will be no greater than one (1) foot.

b. Regardless of the size of the culvert or bridge, the street crossing should be designed to convey the one-year storm runoff flow under and/or over

the road to the area downstream of the crossing to which the flow would have gone in the absence of the street crossing. The construction of a channel crossing must not cause the diversion of drainage flows except when that diversion is part of an approved plan for modification of drainage patterns.

(4) *Streets as water carriers.* It is expected that streets will carry water from adjacent property and from local areas, but they are not to be used as major water carriers in lieu of natural washes or man-made channels. The maximum depth for water flowing in any street shall be eight (8) inches during the peak runoff from a one-hundred-year-frequency storm. The above requirements imply that in some cases water may flow deeper than a normal vertical curb height and may flow for a short distance over sidewalk or other back-of-curb areas, but the flow of the water shall always be confined to the road right-of-way or to drainage easements. Particular care must be taken in street sag locations to insure that these requirements are met. Catch basins, scuppers, or similar facilities, together with the necessary channels, must be provided at appropriate locations to remove water flowing in the streets so as not to exceed the above described depth limit.

(5) *Design procedures and criteria.* The design procedures and criteria to be used shall be in accordance with those prepared and published by the city.

(6) *Lowest floor elevations in residential structures.*

a. In regulatory floodways, a new residential structure or the substantial improvement of an existing residential structure shall have its lowest floor constructed above the regulatory base flood elevation in the vicinity of the proposed construction site. In the regulatory floodway known as the Indian Bend Wash, a lowest floor elevation must also be above the water surface elevation calculated for floodwater flowing at the rate established by the U.S. Army Corps of Engineers' Indian Bend Wash Project design criteria.

b. In special flood hazard areas, a new residential structure or the substantial improvement of an existing residential structure shall have its lowest floor constructed at least one (1) foot above the base flood elevation.

c. In flood hazard zone AO, a new residential structure or the substantial improvement of an existing residential structure shall have its lowest floor (including basement) elevated above the highest adjacent grade at least as high as the depth number specified on the FIRM (at least two (2) feet if no depth number is specified).

d. In areas outside of special flood hazard areas which are not in a regulatory floodway, a new residential structure (single- or multi-family) shall be constructed according to one (1) of the two (2) following requirements, except when the conditions in subparagraph f. apply:

1. The lowest floor shall be constructed at an elevation which is above the base flood water surface elevation.

2. The lowest floor may be constructed below the base flood water surface elevation, but flood proofing shall be provided for the structure to an elevation which is at least one (1) foot above the base flood water surface elevation.

e. In areas outside of special flood hazard areas those single-family residential structures which are to be built without a basement and located at a site which the floodplain administrator has determined will not be in the vicinity of a watercourse in which the flow of rainfall runoff might be hazardous to the structure or its occupants, the elevation of the lowest

floor may be established by one (1) of the methods described in the following subparagraphs:

1. If the structure is to be located in flood hazard zone B, C, D or X, the lowest floor may be set at an elevation which is fourteen (14) inches above the highest adjacent grade.

2. The floor elevation(s) chosen for the residence may be indicated on a topographic plan of the building site parcel which shows the construction pad site and any grading proposed on the parcel. This plan must be prepared and sealed by a civil engineer or architect registered as a professional engineer or architect in the state. The floor elevation(s) indicated on the plan are to be elevations certified by the engineer or architect sufficiently high to provide protection during the base flood in the event of flooding caused by a one-hundred-year storm. This method may be appropriate for residences to be built in environmentally sensitive areas and where the floor levels are stepped to conform with natural grade conditions.

f. A residential structure to be built adjacent to but not within a regulatory floodway that will have its lowest floor at an elevation lower than the regulatory base flood elevation must be floodproofed to an elevation at least one and five tenths (1.5) feet above the regulatory base flood elevation.

g. In regulatory floodways and in special flood hazard areas a depressed floor area shall be considered the lowest floor unless there is a basement.

h. In areas outside special flood hazard areas which are not in a regulatory floodway, a depressed floor area does not have to be considered as the lowest floor if there is no door opening directly to the outside which could admit flood water into the depressed floor area and if the depressed area walls and floor are sealed to prevent the infiltration of water into the depressed area.

(7) *Lowest floor elevations in nonresidential structures.*

a. In regulatory floodways and in special flood hazard areas a new nonresidential structure or the substantial improvement of an existing nonresidential structure shall be constructed according to one (1) of the two (2) following requirements:

1. The lowest floor shall be constructed at an elevation which is above the regulatory base flood elevation in the vicinity of the proposed construction site. In the regulatory floodway known as the Indian Bend Wash, a lowest floor elevation must also be above the water surface elevation calculated for floodwater flowing at the rate established by the U.S. Army Corps of Engineers' Indian Bend Wash Project design criteria, or

2. The lowest floor may be constructed below the regulatory base flood elevation, or floodproofing shall be provided for the structure to an elevation which is at least one (1) foot above the regulatory base flood elevation, or two (2) feet above the base flood water surface elevation. In the regulatory floodway known as the Indian Bend Wash, floodproofing shall be provided for the structure to an elevation which is one (1) foot above the water surface elevation calculated for floodwater flowing at the rate established by the U.S. Army Corps of Engineers' Indian Bend Wash Project design criteria.

b. In flood hazard zone AO, a new nonresidential structure or the substantial improvement of an existing nonresidential structure shall be constructed according to one (1) of the two (2) following requirements:

1. The lowest floor (including basement) elevated above the highest adjacent grade at least as high as the depth number shown on the FIRM (at least two (2) feet if no depth number is specified.

2. The lowest floor may be constructed below the minimum lowest floor elevation specified in subparagraph (1), above, but floodproofing shall be provided for the structure to an elevation which is at least as high as the minimum lowest floor elevation determined by the method in subparagraph (1), above.

c. In areas outside of special flood hazard areas, new nonresidential structure or the substantial improvement of an existing nonresidential structure shall be constructed according to one (1) of the two (2) following requirements:

1. The lowest floor shall be constructed at an elevation which is at or above the base flood water surface elevation.

2. The lowest floor may be constructed below the elevation of the base flood water surface elevation but floodproofing shall be provided for the structure to an elevation which is at least as high as the base flood water surface elevation.

d. In flood hazard zones AH, and AO, adequate drainage paths must be constructed to guide floodwaters around and away from the structures.

(8) *Manufactured homes and manufactured home parks.*

a. The new installation of a manufactured home in an area other than a manufactured home park, the construction of a new manufactured home park, or the enlargement of an existing manufactured home park within a regulatory floodway is prohibited.

b. The new installation of a manufactured home or the replacement of an existing manufactured home outside the special flood hazard areas must be done in a manner that assures that the manufactured home is anchored to the earth so as to prevent flotation, collapse or lateral movement in the event of flooding.

c. A manufactured home to be installed in a new location or as a replacement for an existing manufactured home in a special flood hazard area and a manufactured home to be installed as a replacement for an existing manufactured home located within a regulatory floodway shall be anchored to resist flotation, collapse or lateral movement by providing over-the-top and frame ties to ground anchors. The following specific requirements must be met:

1. Over-the-top ties must be provided at each of the four (4) corners of the manufactured home. Manufactured homes fifty (50) feet or more in length must have two (2) additional over-the-top ties per side at intermediate locations, and mobile manufactured homes less than fifty (50) feet in length must have one (1) additional over-the-top tie per side.

2. Frame ties must be provided at each of the four corners of the manufactured home. Manufactured homes fifty (50) feet or more in length must have five (5) additional frame ties per side, and manufactured homes less than fifty (50) feet in length must have four (4) additional frame ties per side.

3. All components of the anchoring system must be capable of resisting forces of at least four thousand eight hundred (4,800) pounds.

4. Any additions to a manufactured home must be similarly anchored.

d. The owners of manufactured home parks that are located within special flood hazard areas shall have evacuation plans prepared indicating alternate vehicular access and escape routes. These plans shall be filed with the Maricopa County Department of Civil Defense and Emergency Services and with the city's field services director.

e. If an existing manufactured home park within a regulatory floodway must undergo repair, reconstruction or improvement of the streets, utility systems and pads at a cost which equals or exceeds fifty (50) percent of the value of the streets, utility systems and pads before the repair, reconstruction, or improvement has commenced, the following requirements must be met:

1. All manufactured homes are placed on pads or lots elevated on compacted fill or on pilings so that the bottom of the structural frame or the lowest point of any attached appliances, whichever is lower, is at or above the regulatory flood elevation.

2. Adequate surface drainage and access for a hauler must be provided.

3. If the stands are elevated on pilings, the lots must be large enough to permit steps, the pilings must have foundations on stable soil and be no more than ten (10) feet apart, and reinforcement must be provided for pilings more than six (6) feet above the ground.

f. A manufactured home which is located in a regulatory floodway or in a special flood hazard area may be replaced by another manufactured home only if:

1. The manufactured home which is to be replaced was not damaged by a flood to more than fifty (50) percent of its value before the flood.

2. The replacement manufactured home is elevated so that the bottom of the structural frame or the lowest point of any attached appliances, whichever is lower, is above the regulatory base flood elevation.

(9) *Reference to regulatory base flood water surface elevations on development plans.* The grading and drainage plans for any development adjacent to a regulatory floodway and the grading and drainage plans for any development which proposes to modify an existing regulatory floodway as a part of the development must indicate the base flood water surface elevations.

(10) *Information pertaining to flood protection to be placed on building plans.* The following subparagraphs describe requirements for information which shall be placed on building plans for both residential and nonresidential structures. Depending upon the type of structure and its location, one (1) or more of the subparagraphs will apply:

a. The proposed elevation of the lowest floor must be shown, regardless of the type of structure or its location.

b. If the structure is to be built in a regulatory floodway or in a special flood hazard area, the base flood water surface elevation must be shown.

c. If the structure is to be built in flood hazard zone AO, the elevation of the highest ground adjacent to the structure and the depth number for the AO zone must be shown.

d. If the structure is to be floodproofed, the elevation to which the floodproofing will be provided must be shown.

(11) *Minimizing potential for flood damage.* Within any area of the city where the floodplain administrator determines that the land is subject to flooding, including, but not limited to, the special flood hazard areas, all development, including substantial improvements to structures, must meet the following requirements:

a. All structures shall be anchored to their foundations to prevent flotation, collapse, or lateral movement.

b. Building construction materials and utility system equipment shall be resistant to flood damage.

c. The construction methods and practices shall be those which minimize flood damage.

d. Multiple occupancy developments such as subdivisions, shopping centers, etc. shall have their public utility systems such as sewer, water, gas and electrical lines and their associated facilities located and constructed in a manner to minimize or eliminate the potential for flood damage. The developments must be constructed with drainage systems which will minimize the exposure to flood damage.

e. New and replacement water supply systems shall be designed and constructed to minimize or eliminate infiltration of floodwater into the systems.

f. New and replacement sanitary sewage systems shall be designed and constructed to minimize or eliminate infiltration of floodwaters into the systems and the discharge of sewage into the floodwaters.

(12) *Storm water storage facilities.*

a. Except as noted below, development of all land within the city must include provisions for the management of stormwater runoff from the property which is to be developed. This management shall consist of constructing storm water storage facilities, which includes detention basins. Stormwater storage facilities will provide reduced peak rates of outlet flow from the developed property onto downstream property in comparison to the peak rates of runoff flow from the same property under natural conditions with no development. As a minimum, all development will make provisions to store runoff from rainfall events up to and including the one-hundred-year two-hour duration event. If a suitable outlet for a detention basin is not available, or if engineering analysis indicates that available outlet systems would be overtaxed by a detention basin outflow, or groundwater recharge is indicated by an approved master groundwater recharge plan a retention basin shall be constructed in lieu of a detention basin.

The requirement for construction of a detention system or a retention basin all types of stormwater storage facilities may be is waived in the following cases:

1. The runoff has been included in a storage facility at another location.

2. An application for a building permit to construct a single-family residential structure.

3. Development adjacent to a floodway or a watercourse drainage channel which has been determined by the project review manager using engineering analyses provided by the development to have

been designed and constructed to handle the additional runoff flow without increasing the potential for flood damage on any other downstream property.

4. Development of a parcel under one-half acre in an area where it can be demonstrated by engineering analyses that no significant increase in the potential for flood damage will be created by the development.

If storage is waived, the development shall be required to contribute to the cost of drainage works on the basis of runoff contribution.

b. Stormwater storage facilities shall be designed and constructed according to the procedures and criteria established by the city including the following:

1. The extent of the area to be used to estimate development storage requirements is the entire proposed development including: streets, alleys, easements and rights-of-way, and one-half or other fractional parts of streets, alleys, easements and rights-of-way.

2. If possible, storage facilities are to be located so they can intercept the flow from the entire development;

3. If portions of the area cannot drain to a primary storage facility then additional facilities are to be added for these areas as approved by the director of project review;

4. Individual lot facilities are prohibited except when a clear unobstructed access from a public rights-of-way, for maintenance purposes, is conveyed by dedication or easement to the city;

5. No stormwater storage facility shall detain or retain standing water longer than thirty-six (36) hours if the basin has not been designed and constructed to be a permanent body of water with appropriate health, safety, and water quality measures for such a body of water.

c. Stormwater storage facilities are to be drained by either controlled bleed-off, discharge pump and, in limited cases, by infiltration or dry well or injection wells. Controlled bleed-off or pumping to a recognized water course is the preferred method. Methods which discharge stored stormwater to the underground must be in accordance with the approved groundwater master plan and approved by the floodplain administrator, the director of project review and the water resources director. In addition, the development must provide the director of project review the state and federal permits required to discharge stormwaters to the underground prior to the issuance of any other development permit.

(13) *Parking in flood hazard areas.* Parking areas shall be permitted within regulatory floodways and special flood hazard areas provided that there will be no overnight parking, that there will be no unattended vehicle(s), and that there will be no obstruction to the natural flow of water.

a. Overnight parking shall be considered to exist when a vehicle is left unattended during the hours from sunset to sunrise.

b. "Unattended" shall mean that the owner or authorized driver cannot reasonably be expected to be available to remove the vehicle before flooding occurs.

Whenever parking is permitted within regulatory floodways and special flood hazard areas, warning signs shall be posted by the parking area owner to indicate that the parking area is subject to flooding.

(14) *Special considerations in environmentally sensitive land areas.*

a. Existing watercourses with a capacity of fifty (50) cubic feet per second or greater, disregarding any estimated peak discharge values, shall be maintained in their natural state unless it is determined that alterations are required to meet other provisions of this ordinance.

b. A drainage and flood control easement will be dedicated to the city which encompasses the area required to convey the base flood in the watercourse described in section 37-42(14)a.

c. Road-wash crossings may disrupt the natural channel beyond the right-of-way limits if engineering investigations determine the need, and are approved by the director of project review.

d. Stormwater storage facilities may not be required in areas zoned for environmentally sensitive development if the city staff determines that such facilities cannot be built without conflicting with the city's environmentally sensitive lands ordinance requirements. If on-site stormwater storage facilities requirements are waived, the development may be required to contribute to the cost of drainage works at another location on the basis of runoff contribution.

e. All drainage structures and detention facilities shall be constructed in such a manner as to minimize the impact on the natural environment, promote recharge when in conformance with the approved groundwater, recharge master plan and, when finished, shall be revegetated to be compatible with nearby natural areas.

(15) *Conformance with state law.* No construction within the limits outlined in this article shall be permitted which would violate prevailing water law of the state, whether statutory or by the courts of this state.

(Code 1972, § 5-615(B); Ord. No. 1993, 2-29-88)

Sec. 37-43. Requirement for certifications and required permits.

(a) Before the city will make a final inspection and grant a utility clearance for a single-family residential structure built in a regulatory floodway, a special flood hazard area or in flood hazard zones A or AO, or before the city will grant a certificate of occupancy for a structure other than a single-family residential structure built in a regulatory floodway, a special flood hazard zone or in flood hazard zones A or AO, the builder must submit certain certificates to the floodplain administrator. The certificates which are required pertain to lowest floor elevations, adjacent ground elevations and floodproofing. The following subparagraphs describe the required certificates.

(b) Certificates pertaining to elevations shall be made by either a civil engineer or land surveyor who is registered to practice in the state.

(c) Certificates pertaining to the adequacy of floodproofing shall be made by a civil engineer or architect who is registered to practice in the state.

(d) A certificate shall be submitted stating the "as-built" elevation (in relation to mean sea level) of the lowest floor of each new structure or substantial improvement to a structure built in a regulatory floodway or in a special flood hazard area. If the lowest floor is below grade on one (1) or more sides, the certificate must also state the elevation of the floor immediately above the lowest floor. This certificate must indicate whether the structure does or does not have a basement. If a structure has been floodproofed, a statement of the elevation to which the structure was floodproofed must be included with this certificate.

(e) For those structures which have been built in a regulatory floodway or in a special flood hazard area and have been floodproofed, a certificate shall be submitted which certifies that the floodproofing methods are adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the base flood conditions expected at the building site.

(f) Other permits. The city, being a participant in the National Flood Insurance Program and subject to certain federal rules associated with that program; other federal rules and directives, and; subject to the statutes of the state, establishes the following methods to manage those laws and rules when applicable:

(1) *Floodplain and drainage management permit.* Prior to issuance of a building permit, a floodplain and drainage management permit shall be obtained. The application for a permit will be on forms provided by the floodplain administrator and must include, but not be limited to, plans drawn to scale showing the nature, location, dimensions, and elevation of the area in question; existing or proposed structures, fills and excavations, drainage facilities, and; locations of the foregoing. The following information is required to be included in the application specifically:

a. In relation to mean sea level, existing ground elevations and proposed elevation of the lowest habitable floor for all structures including basements;

b. Proposed elevation in relation to mean sea level, to which any structure will be floodproofed;

c. Description of the extent to which any watercourse will be altered or relocated as a result of proposed development; and

d. Any certifications required by this ordinance, state law and federal rules.

(2) *Evidence of state and federal permits.* Prior to start of construction the developer must submit evidence to the director of project review that necessary state and federal permits have been obtained.

(Code 1972, § 5-615(C); Ord. No. 1993, 2-29-88)

Sec. 37-44. Obstruction of waterway--Prohibited.

No person in the city shall either obstruct or reduce the capacity of a watercourse by any use or by filling, dumping, or constructing or by any other means, except as provided in this article.

(Code 1972, § 5-618(A); Ord. No. 1993, 2-29-88)

Sec. 37-45. Same--Removal of obstructions.

(a) Any person who owns, occupies, or leases real property within the city and who obstructs or reduces the capacity of a watercourse other than as provided for in this article, shall be deemed to have created a public nuisance. Such persons shall be notified in writing, either personally delivered or by certified or registered mail, return receipt requested, by the floodplain administrator or his authorized representative, to remove the obstructions or the materials creating the reduction of the capacity of a watercourse within ten (10) days after receipt of said written notice. If the owner does not reside on such property, a duplicate shall also be sent to him at his last known address.

(b) If the owner, lessee, or occupant of such real property, after having been given notice as required above, does not comply and abate such conditions which constitute a public nuisance, the floodplain administrator shall be authorized to abate such condition at the expense of such owner, lessee or occupant.

(c) The floodplain administrator, or his authorized representative, shall prepare a verified statement and account of actual cost of such abatement, including inspection and other incidental costs in connection with such abatement. Said verified statement and account is hereby declared as a debt of such owner, lessee, or occupant. A copy of said statement and account shall be personally delivered or delivered by certified mail, return receipt requested, to the party served with the original notice. The city attorney may institute an action to collect the debts so created in the superior court of the county at any time after delivery of the statement and account.

(d) Within ten (10) days after receipt of the notice described in subsection (a), any person may appeal the city's request by serving written notice of appeal upon the city clerk and shall be entitled to a hearing before the floodplain board on the appeal. In the event such an appeal is filed, all proceedings shall be stayed pending disposition of the appeal. Any

person may also appeal to the floodplain board within ten (10) days after the receipt of the statement and account prepared and served pursuant to subsection (c) the amount of said debt by serving written notice of appeal upon the city clerk which also shall stay all further proceedings pending disposition of the appeal.

(e) When, in the opinion of the floodplain administrator, there is immediate danger to life or property, constituting an emergency, as the result of any obstruction or reduction of the capacity of a watercourse not authorized under this article, he may order the immediate abatement of said condition notwithstanding the notice provisions provided in subsection (a) of this section. The cost of said abatement shall be collected in the same manner as other debts, as provided for in subsection (c) of this section.

(Code 1972, § 5-618(B); Ord. No. 1993, 2-29-88)

Sec. 37-46. Penalties.

Any person, corporation, partnership or association violating or failing to comply with the provisions of this article shall, upon conviction thereof, be guilty of a class 1 misdemeanor, or appropriate actions or proceedings to prevent such acts as may be filed in a court of competent jurisdiction.

(Ord. No. 1993, 2-29-88)

Sec. 37-47. Severability.

This article and the various parts thereof are hereby declared to be severable. Should any provision of this article be declared by the courts to be unconstitutional or invalid, such decision shall not affect the validity of the article as a whole, or any portion thereof, other than the provision so declared, to be unconstitutional or invalid.

(Ord. No. 1993, 2-29-88)

Sec. 37-48. Conflict.

This article shall take precedence over any conflicting ordinance of the city.

(Ord. No. 1993, 2-29-88)

DIVISION 3. DRAINAGE FACILITY DEVELOPMENT FEES

Sec. 37-49. Purpose.

The purpose of this section is to impose development fees to reimburse the city for financing and constructing necessary public drainage and related improvements on lands owned by the State of Arizona within the Reata Pass Wash Desert Greenbelt Improvement District No. 18902, and thus make possible the beneficial use of the property to be developed.

(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-50. Definitions.

Developer means the person that is responsible for creating a demand for drainage facilities.

Development means any proposed improvement to property that creates a demand for the drainage facilities in the area of the Reata Pass Wash Drainage Improvement Program.

Drainage improvement program means those drainage facility improvements set forth in the report.

Person means an individual, corporation, a partnership, an incorporated association, or any other similar entity.

Report means the document entitled Project Cost Estimate and Assessment Methodology dated February 2, 1998, prepared by Simons, Li and Associates.

(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-51. Drainage development fee imposed.

(a) There is hereby imposed within the Reata Pass Wash Desert Greenbelt Improvement DistrIct No. 18902, as depicted on the following map, a drainage development fee on all new development on property that has been owned by the Arizona State Land Department and thus has not paid improvement district assessments in the Reata Pass Wash Desert Greenbelt Improvement District No. 18902.

(b) The developer shall pay to the city the drainage development fee at the time and as a condition of the issuance of building permits for new residential dwelling units or non residential structures.

(Ord. No. 3131, § 1, 5-4-98)

INSET:

Sec. 37-52. Fee amount.

(a) The amount of the development fee shall be three thousand six hundred twenty-five ($3,625.00) per acre, plus the cost of interest on that amount equal to that paid by the city for the general obligation bonds sold to finance the Reata Pass Wash drainage improvements.

(b) The interest cost will be calculated by the city financial services general manager, or his designee, for each development at the time that the development fee is paid, based on the time between the date of the sale of the bonds and the time the fee is to be paid. The city financial services general manager, or his designee, shall provide to the city development services director a schedule for the payment of interest to be used for the purposes of this section.

(c) For development of less than an acre, the amount of the fee shall be proportionate to the acreage involved. In the case of platted properties, the acreage attributable to common areas of the plat shall be allocated proportionally to individual lots within the plat at the time the plat is approved.

(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-53. Payment of the fee.

(1) The fee shall be paid in cash by the developer or the person authorized on his behalf to apply for the issuance of a construction permit, to the city development services director or his designee. No construction permit may be issued by the city until such fee has been paid.

(2) The city may accept the offer by the developer to construct or otherwise provide all or part of the improvements (including the dedication of land) that are contained in the drainage improvements program for the Reata Pass Wash. The construction of the drainage improvements must be in accordance with the engineering and design standards of the drainage improvements program.

(a) The timing of completion, the necessary security for completion of construction, the standards for acceptance of the construction and other construction matters, the legal descriptions of and the allocation of dollar amounts of the value of the fee otherwise due in lieu of construction per development parcel within a larger development, and other such matters as are appropriate shall be the subject of an agreement between the developer and the city. Drainage improvements that are local to the site, and which therefore do not serve the regional purposes of the drainage improvement program are not eligible for such credits.

(b) Thereafter, drainage fees collected pursuant to this division for the property subject to the development agreement shall be refunded by the city to the developer within thirty (30) days of the end of the quarter in which the drainage fees have been paid. Credits shall be payable for a period of up to twenty (20) years from the date the city issues its final acceptance of the drainage improvements pursuant to the development agreement.

(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-54. Drainage development fee fund.

There is hereby established a drainage development fee fund, into which all fees collected pursuant to this section shall be held. Monies withdrawn from this fund must be used for the purpose of providing drainage improvements in the Reata Pass Wash area consistent with the

drainage improvements program as set forth in the report. Interest earned on the monies in the fund shall be credited to the fund.
(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-55. Use of fees.

Fees collected pursuant to this section shall be used solely for the purpose of acquiring, equipping, financing and/or installing improvements to the Reata Pass Wash Drainage Improvements Program and shall not be used for maintenance or operations. At least once each fiscal period, the city manager or designee shall present to the city council a report on the use of the fees collected in the fund for specific drainage improvements in the Reata Pass Wash Drainage Improvement Program.
(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-56. Refund of drainage development fees.

Any funds not expended or encumbered within fifteen (15) years from the date the drainage development fee was paid are refundable upon application of the developer or its successor. Development fees shall be deemed expended or encumbered in the order received by the city on a first-in, first-out basis. Development fees are expended or encumbered when actually paid by the city or when a lease, purchase, construction option or other contract or agreement creating an absolute or continuing obligation to pay and relating to the purposes of this section has been approved by the city council. Written application for a refund shall be made within one (1) year after the date the development fee becomes refundable and shall include documentation sufficient to establish the date and amount of the development fee payment. Development fees for which no timely refund application is made may be expended by the city for the purposes stated in this section.
(Ord. No. 3131, § 1, 5-4-98)

Sec. 37-57. Review of fee.

The drainage development fee adopted by this section shall be reviewed at least once every three (3) years by the city council to determine if any changes to the fee or its administration may be appropriate.
(Ord. No. 3131, § 1, 5-4-98)

APPENDIX B

Application to Release Existing Drainage Easement

_____RE_____

CITY OF SCOTTSDALE
PROJECT REVIEW **Q/S**_____

APPLICATION TO RELEASE EXISTING DRAINAGE EASEMENT (D.E.)

For information regarding release of this drainage easement, call (480) 312-7696.

APPLICANT: _____ DATE: _____

ADDRESS: _____

_____

PHONE: _____FAX: _____

In order to begin the easement release process, the following information must be submitted for review by city staff:

1. Evidence of property ownership. (i.e. deed or title report no more than 90 days old)

2. Written explanation of the reason(s) the easement should be released. One of the following conditions must exist and be clearly documented on the Grading and Drainage Plan (G&D) and in the Drainage Report before the release of a drainage easement will be considered:
   a.) Upstream flows have been physically cutoff or diminished.
   b.) More detailed topographic mapping and aerial photography has shown the original easement dedication to be incorrectly located.
   c.) The original hydrology was found to be out of date or in error.
   d.) Internal relocation of the watercourse or drainage facility, as long as it is not a natural wash within the ESL area, that has a capacity of 50 cfs or greater.

3. A statement by a registered civil engineer in the State of Arizona certifying that the abandonment or modification and rededication will not increase flood levels, and will not increase flooding hazards within, upstream or downstream of the altered portion of the watercourse.

4. A legal description of the easement(s) to be released prepared and sealed by a land surveyor registered in the state of Arizona. A graphic of the easement(s) to be released prepared and sealed by a land surveyor registered in the state of Arizona.

5. Copy of the original recorded easement document.

6. Two G&D plans, clearly depicting the existing D.E. and proposed conditions (location of the proposed new easement) and one Drainage Report. Both must be prepared and sealed by a civil engineer, registered in the state of Arizona.

7. If a modification or relocation is proposed the applicant shall provide a legal description and exhibit of the new easement(s), prepared and sealed by a land surveyor registered in the state of Arizona. All documents must meet the Maricopa County Recorders office requirements for recordation.

8. One copy of a combination, one-hundred scale, city LIS aerial photo, with easements, and parcel layers overlaid with subject parcel clearly identified, with as a minimum, all adjacent parcels included.

9. Non-refundable processing fee of $619.00.

_____

Signature of Applicant

NOTES: 1. This is only an application and in no way guarantees the release of any easement(s).
2. City staff reserves the right to request information not listed above in order to make a determination with regard to the release of any easement.

PAGE 2
APPLICATION TO RELEASE EXISTING DRAINAGE EASEMENT

Project Name: _____ _____**RE**____

This **APPLICATION TO RELEASE EXISTING DRAINAGE EASEMENT** has been submitted for review. If there are outstanding issues or the request is unacceptable, redline the plan and report, make the appropriate comments below and return the entire package to applicant for correction. If the application is in order and the release can be made sign below and pass the package on to the next reviewer.

Civil Plan Reviewer: _____ Date: _____ Phone: _____

Drainage Planning Reviewer: _____ Date: _____ Phone: _____

Review Item	Comments

Signatures for Final Approval:

_____ _____

Development Quality/Compliance Director **Date**

_____ _____

Floodplain Administrator **Date**

APPENDIX C

City of Scottsdale
Section 404 Certification Form

CITY OF SCOTTSDALE SECTION 404 CERTIFICATION FORM

Before the city issues development permits for a project, the developer's Engineer or the property owner must certify that it complies with, or is exempt from, Section 404 of the Clean Water Act of the United States. [Section 404 regulates the discharge of dredged or fill material into a wetland, lake, (including dry lakes), river, stream (including intermittent streams, ephemeral washes, and arroyos), or other waters of the United States.

Prior to submittal of improvement plans to Project Review the form below must be completed (and submitted with the improvement plans) as evidence of compliance.

Certification of Section 404 Permit Status

Owner's Name: _____Phone No. _____

Project Name/Description: _____Case No._____

Project Location/Address: _____

_____

A registered Engineer or the property Owner must check the applicable condition and certify by signing below that:

1. Section 404 does apply to the project because there will be a discharge of dredged or fill material to waters of the U.S., and:

☐ **a: A Section 404 Permit has already been obtained for this project.**

-or-

☐ **b: This project qualifies for a "Nationwide Permit," and this project will meet all terms and conditions of the applicable nationwide permit.**

2. Section 404 does not apply to the project because:

☐ **a: No watercourses or other waters of the U.S. exist on the property.**

-or-

☐ **b: Watercourses or other waters of the U.S. do exist on the property, but the project will not involve the discharge of dredged or fill material into any of these waters.**

I certify that the above statement is true.

_____ _____

Engineer's Signature and Seal, or Owner's Signature Date

_____ _____

Title Company

APPENDIX D

Request for Stormwater Storage Waiver Form

City of Scottsdale Case Numbers

_____PA_____ _____DR_____

_____ZN_____ _____PP_____

_____UP_____

Before the submittal of improvement plans the developer must obtain approval of this waiver request. Denial may require a revised site plan be submitted to the DR Board.

REQUEST FOR STORMWATER STORAGE WAIVER FORM (Page 1 of 3)

(To be completed by the applicant and submitted to the city for processing)

Waiver Criteria

A waiver is an intentional relinquishment of a claim or right. Before the city can waive some or all of the required stormwater storage at least one of the following city ordinance criteria (**in bold**) must be met. Check the criteria below that applies to this project and provide the engineering analyses that demonstrate that the effect of this waiver will not increase the potential for flooding on any property.

☐ 1. **The runoff has been included in a storage facility at another location.** The developer must demonstrate that runoff from this site will be safely conveyed to the other location through an adequately designed conveyance facility.

☐ 2. **Application is for a building permit to construct a single-family residential structure.**

☐ 3. **Development is adjacent to a watercourse or channel that has been designed and constructed to handle the additional runoff flow without increasing the potential for flood damage to any other downstream property.** The developer must demonstrate that the watercourse has the extra capacity needed to convey the additional runoff.

☐ 4. **The development is for a parcel under one-half acre in an area where it can be demonstrated by engineering analysis that no significant increase in the potential for flood damage will be created by the development.**

☐ 5. **There is a possible conflict with the requirements of the city's Environmentally Sensitive Lands Ordinance** (city staff must make the final determination of this)**.**

I, _____ _____ certify that:
DEVELOPER OR ENGINEER **DATE**

The _____ meets one of the criteria checked above.
PROJECT or DEVELOPMENT NAME

Project Location _____

Applicant Phone ( ) _____

Applicant Mailing Address .

I, _____ _____ believe that the above is correct and the project (**does**) / (**does not**) meet one or more of the waiver criteria.
PROJECT COORDINATION STAFF **DATE**

REQUEST FOR STORMWATER STORAGE WAIVER FORM (PAGE 2 of 3)

(To be completed by applicant and submitted to the city for processing)

IN-LIEU FEE CALCULATIONS

If the city grants a waiver, the developer is required to contribute the following In-Lieu Fees for the cost of drainage facilities as determined in 1, 2, or 3 below. Please check the appropriate box for determining the In-Lieu fee.

Project Name _____

☐ **1. The fee is based on runoff contribution determined as follows:**

_____

_____

_____

The scope and cost of drainage facilities that fees are being contributed towards include the following components:

- _____ $_____
- _____ $_____
- _____ $_____

In-lieu Fees TOTAL **$**_____

☐ **2. The fee is based on what it would have cost to provide the volume of storage being waived. Payment in-lieu of stormwater storage shall include all applicable costs, including but not limited to:**

- Land costs $_____
  (documentation must be provided for verification of land costs)
- Construction costs
  - Excavation and disposal _____
  - Fill _____
  - Inlet and outlet structures _____
  - Overflow structures _____
- Plant salvage and/or revegetation costs _____
- Other costs _____ _____

In-lieu Fees TOTAL **$**_____

IN-LIEU FEES CALCULATED BY _____ _____

DRAINAGE PLANNER **DATE**

☐ **3. No In-Lieu Fee recommended by city staff.**

Reason _____

RECOMMENDED BY _____ _____

DRAINAGE PLANNER **DATE**

APPROVED BY _____ _____

FLOODPLAIN ADMINISTRATOR **DATE**

REQUEST FOR STORMWATER STORAGE WAIVER FORM (PAGE 3 of 3)

(This page to be completed by city staff)

Project Name _____

CHECK APPROPRIATE BOXES

☐ **Waiver criteria met (specify):** ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

☐ **Waiver approval recommended.**

☐ **Waiver recommended for denial:**

- ☐ None of the waiver criteria met.
- ☐ Downstream conditions prohibit the waiver of any storage.
- ☐ Other: _____

Explain: _____

_____

☐ **Waiver request returned:**

- ☐ Insufficient data provided.
- ☐ Other: _____

Explain: _____

_____

Recommended Conditions of Waiver:

- ☐ All storage requirements waived.
- ☐ Pre development conditions must be maintained.
- ☐ Other: _____

Explain: _____

_____

Above Recommended by: _____ _____

DRAINAGE PLANNER **DATE**

WAIVER: _____ **APPROVED; OR** _____**DENIED , per above conditions:**

By _____ _____

FLOODPLAIN ADMINISTRATOR **DATE**

By _____ _____

DEVELOPMENT QUALITY/COMPLIANCE DIRECTOR **DATE**

Section 2.2

HYDROLOGY AND DRAINAGE REPORT PREPARATION

DESIGN STANDARDS AND POLICIES
REVISED DECEMBER 1999

CHAPTER 2
DRAINAGE

SECTION 2.2
HYDROLOGY AND DRAINAGE
REPORT PREPARATION

CONTENTS

FIGURES

SECTION 2.2
HYDROLOGY AND DRAINAGE REPORT PREPARATION

2-201 INTRODUCTION

A. General Comments

This manual section describes the city's policies concerning hydrologic analysis procedures to be used in the city of Scottsdale for the planning and design of drainage and flood control facilities and the preparation of accompanying drainage reports. This manual contains recommended procedures, equations, data and basic assumptions which the planner or designer is generally required to use. If a situation is encountered in which the use of other methods or data in addition to or instead of those presented here are believed to be more appropriate, then city Drainage Planning staff should be consulted and advance approval must be received before using them. When methods or data not described in this booklet are used, the drainage report must include enough information to enable the city Staff to fully evaluate the applicability of the methods and data. If a computer program is used that the city does not have in its software library, the consultant must provide the city with a fully usable copy of the appropriate software, or show adequate comparisons with known procedures.

For flood control projects that are cost-shared with the Flood Control District of Maricopa County, the hydrologic design procedure contained in Vol. 1, Hydrology of the Drainage Design Manual for Maricopa County must be used.

B. Goals and Objectives

The following are the basic goals and objectives used as a guide in preparing this manual:

1. Reflect current requirements of the city floodplain and drainage ordinance, as well as other city ordinances and applicable County, State or Federal regulations.

2. Use the best and most current data and methods available.

3. Provide guidance for hydrologic design methods that:

    a. Reflect commonly accepted state of the art procedures;

    b. Produce safe, reasonable, and reliable results (within an acceptable range of values);

    c. Give flexibility to the designer while at the same time maintains a reasonable level of design consistency;

    d. Are not unnecessarily complex or confusing;

    e. Do not require more detailed or complex input data than is commonly available;

    f. Are technically and legally defensible;

    g. Provide results that are consistent with adjacent jurisdictions, primarily the city of Phoenix, the Flood Control District of Maricopa County (FCDMC) and ADOT.

Because of efforts to meet the above goals and objectives, some options in this manual differ slightly from adjacent jurisdictions, such as the Flood Control District of Maricopa County. However, results do not differ significantly. The sensitivity analysis conducted by several independent sources has verified that results are consistent and are within acceptable ranges of seven other methods and six different envelope curves. In addition, results were found to be comparable to:

- An envelope curve of one hundred year frequency peak discharge values for Maricopa County, prepared by ADWR;

- A preliminary plot of flood frequency data for USGS streamflow data from 64 gages located in the Central Region of Arizona, obtained from ADOT; and

- The sample problem in the FCDMC's Hydrology Manual.

C. Application and Limitations

The purpose of this manual is to provide a means of assisting in the estimation of runoff that might result from a design storm of a given return interval.

Hydrology is a discipline, which requires not only technical competence but also experience and good judgment. The city does not warrant or guarantee the reliability of the hydrologic methods, techniques, and/or parameter values described herein. The user of this manual is expected to validate the reasonableness of the estimated values by applying alternative methods or other appropriate checks, which have been developed for this area.

It is not the intent nor purpose of this manual to inhibit sound innovative design or the use of new techniques. Therefore as mentioned previously, where special conditions or needs exist, other methods and procedures may be used with prior city approval and appropriate documentation to support the validity of the methods.

It is anticipated that, over time, as more data becomes available and/or more appropriate techniques are developed, this manual will be revised. Such revisions will probably take

place annually or as needed. If any inadequacies or inaccuracies are found with any of these procedures, they should be brought to the city's attention immediately.

D. Acknowledgments

The information and procedures that are presented in this manual are mainly the result of previously published efforts of many talented individuals. The author of this manual has made every effort to cite the original authors and researchers whose contributions to this manual, and to the science of hydrology, are gratefully appreciated.

The author of this manual is indebted to the many individuals and organizations, including the staff at city of Scottsdale that have supported this effort through recommendations, technical guidance, encouragement, and review of draft sections of this manual. In particular, the following people have provided immeasurable assistance without which this manual could not have been completed in this form. Those individuals, in alphabetical order, are:

Scott Buchanan, Stanley Consultants, Inc., Phoenix, AZ
Ginny Coltman, Drainage Planner, City of Scottsdale
Greg Crossman, former Drainage Planner, City of Scottsdale
Bill Erickson, Drainage Planner, City of Scottsdale
Richard Hawkins, University of Arizona, Tucson, AZ
Ray Jordan, ADOT, Phoenix, AZ
George Lopez-Cepero, ADOT, Phoenix, AZ
Collis Lovely, Drainage Planner, City of Scottsdale (Primary Author)
Jim Mayer, former City of Scottsdale Employee
James R. Morris, formerly with ADWR, Phoenix, AZ
Herbert B. Osborn, Ph.D., P.E., (retired), Arid Lands Watershed Management Research Unit, U.S. Department of Agriculture, Tucson, AZ
Kenneth G. Renard, Ph.D., P.E., Arid Lands Watershed Management Research Unit, U.S. Department of Agriculture, USDA, ARS, Tucson, AZ
Marilyn Suco, former City of Scottsdale Employee
Robert Ward, Consulting Engineer, Mesa, AZ

2-202 DRAINAGE REPORT PREPARATION

A. Requirements for a Drainage Report

A drainage report is required by the city's Floodplain and Drainage Ordinance to:

- document the effect that a proposed project would have upon stormwater runoff;
- provide data to insure that the project will be safe from flooding; and
- to provide data supporting the design of drainage and flood control facilities.

Each drainage report must consider runoff from storms with a return frequency up to and including a 100-year event. The complexity of the report depends upon the nature of the project and the site on which the project will occur.

A drainage report must be prepared by a qualified professional drainage designer and sealed by a professional Civil Engineer registered in the State of Arizona. The design and drainage report must be prepared in accordance with the city's current Floodplain and Drainage Ordinance; the criteria and direction contained within Sections 2.1 - 2.3 of the Design Standards and Policies Manual; and other applicable city policies and criteria.

An applicant is required to submit a drainage report when requesting one of the following:

- Approval of subdivision plat (preliminary and final).
- A permit for grading, unless the requirement is waived by the Floodplain Administrator.
- A permit to construct right-of-way improvements.
- A permit to construct any structure. (A drainage report is not needed if the structure is a single family residential structure without a basement in Flood Hazard Zones X, B, C, or D, and is located at a site which the Floodplain Administrator has determined is not in the vicinity of a watercourse where the flow of rainfall runoff might be hazardous to the structure or its occupants.)
- Zoning case approval.
- The modification or release of a dedicated drainage easement.
- Development review case approval.
- Lot split.

B. The Purpose of a Drainage Report

The purpose of a drainage report is to document that stormwater runoff has been considered in the planning of each project and that the public and its property will be protected from damage by runoff flows and flooding to the extent of the 100-year flood event. The requirement for this protection not only applies to those who will own and/or use a proposed project but also to those who own or occupy property adjacent to or near enough to be affected by the proposed project.

C. Elements of a Drainage Report

Refer to the following Figure 202-C. “Outline for Drainage Reports”, for specific items that must be included (as applicable) for any type of a drainage report including a master drainage plan. Following the outline is a more detailed description of the various sections of the report. See Section 2-205 for a checklist of Master Drainage Plan submittal requirements.

Each drainage report must have a section which includes a narrative, topographic maps and aerial photographs that describes the location and condition of the property where the project is located (on-site conditions) and the upstream (off-site) watersheds as well as any downstream constraints which affect the property.

An essential part of each report is a topographic map, which shows the location of the project area. As a minimum, the city GIS quarter-section topographic maps with either a 1-foot or 2-foot contour interval must be used as the base map. The map need not be elaborate, but it must show the location of the property with respect to the street system and other features such as the Arizona Canal or the CAP Aqueduct. For the area of the city north of the CAP, a city of Scottsdale 400 scale Existing Drainage Network aerial photograph (the most current available) must accompany each drainage report, which shows existing on-site drainage conditions on the property. South of the CAP, the city’s Stormwater Master Plan and any applicable as-built drawings should be used.

Figure 2-202 OUTLINE FOR DRAINAGE REPORTS

Title Page: Project Name, Type of Drainage Report, or Plan; and Author's Seal and Date

Table of Contents: Author's Seal and Date

1. **Introduction**
   - Project Name and Site Location
   - Project Size and Type of Report
   - Purpose and Objectives

2. **Description of Existing Drainage Conditions and Characteristics**
   - On-site drainage:
     - Existing drainage network, patterns, and watershed and floodplain boundaries.
   - Off-site watershed:
     - Existing and future conditions and the drainage network entering the project site.
   - Relation to adjacent drainage plans and projects.
   - Flood Hazard Zones on the property, FIRM maps.

3. **Proposed Drainage Plan**
   - General description of proposed drainage system and components
   - Stormwater storage requirements:
     Volume required, volume provided, and basin locations.
   - Pre- and post-runoff characteristics at concentration points exiting the property.
   - Proposed drainage structures or special drainage facilities:
     Include design criteria and probable effect on the existing upstream and downstream drainage system.

4. **Special Conditions**- Stipulations, 404 Permit, NPDES

5. **Data Analysis Methods**
   - Hydrologic procedures and assumptions.
   - Hydraulic procedures, methods, and assumptions.
   - Stormwater storage calculation methods and assumptions.

6. **Conclusions**
   - Overall Project
   - Project Phasing

7. **References**

Appendices - Hydrologic and Hydraulic Data and Calculations
Floppy Disks - HEC-1; and HEC-2 or HEC-RAS Input Files
Exhibits

- *Vicinity Map*
- *Existing Conditions*
  - *Off-Site Watershed Topographic Map*
  - *Existing On-site Drainage Topographic Maps*
    - *Minimum of city GIS 2-foot contour topographic mapping and city 800 scale aerial photo.*
- *Proposed On-site Drainage Plan*
  - *Scale appropriate to type of drainage report and size of the project.*

D. On-Site Conditions

This section of the report should include the following basic information about the property, as applicable:

- Narrative description of: existing drainage patterns, natural and constructed watercourses, open channels, storm drains, dams, or storage basins; and an existing conditions map showing all the above plus the 100-year floodplain for all washes with a capacity of 50 cfs or greater in ESL areas of the city and 25 cfs in the remainder of the city.

- Description of the existing ground cover conditions and how the identification of the SCS hydrologic soil group(s) or appropriate Green-Ampt soil characteristics were identified for the property.

- Description of any existing development located on the property and how it affects drainage.

E. Off-Site Watershed Conditions

Watersheds above the project area from which stormwater runoff enters or affects the project's property must be delineated on topographic maps. These maps should be prepared at a scale that will clearly show the drainage areas so watershed boundaries can be drawn with accuracy. Contour lines should be shown on the maps at an interval appropriate to the ground slope and complexity of the terrain. Recent photographs of every part of the city are available at scales 1 inch = 100; 400; and 800 feet. The most current aerial photograph(s) must be included in each drainage report that shows the off-site watershed areas and adjacent properties in relation to the project site.

- The section should include:

- Existing upstream and downstream drainage patterns and a description of how existing developments on adjacent properties affect drainage on the project area.

- A description of the ground cover conditions assumed and how the SCS hydrologic soil group(s) or Green Ampt soil classes were determined for the offsite watersheds.

- A description of fully developed offsite conditions in accordance with the approved Land Use Plan for Scottsdale as approved by the City Council, and a discussion of any potential adverse affects on this project.

- A description of any proposed projects or developments, that have approved designs, that will affect property. Review approved drainage plans and reports for development or CIP projects that may impact drainage on the property.

- Describe any other unusual conditions, which would significantly affect drainage on the property.

F. Proposed Drainage Plan

The section must describe how the proposed project will manage stormwater runoff and the sequence of infrastructure installation and any planned phasing of the project.

- <u>Depicting pre- and post-project topography:</u> Prior to the project or development of a piece of property, topographic conditions exist on the property which will influence flow of drainage water which enters the property from watersheds above it or which

originates on the property. When the project has been completed, certain topographic changes will have occurred which influence the drainage and the resulting time of concentration. The drainage report must include sufficient pre- and post-project topographic information to demonstrate the effects of the project. This information should be depicted on contour maps. In addition to showing the developer's property, these maps should also show enough of the adjacent property to give a clear picture of what exists there that will affect drainage. Information about adjacent property, such as significant differences in elevation, walls, drainage structures, buildings with their floor elevations, etc. must be included.

- Pre- and Post-Project Stormwater Runoff: The amount and type of stormwater runoff that would exit the property prior to the project and after the project must be depicted for a 2-year, 10-year and a 100-year storm. If, as a result of the project, drainage flows will be reduced by facilities such as stormwater storage basins, the effect of these facilities on flows exiting the property should be described and depicted on appropriate maps. Construction of roads, parking areas, roofs, channels, and other project features generally increases the runoff volume and peak discharge and reduces the time of concentration.

- The Basis of Design for Drainage and Flood Control Facilities: Summarize the design criteria used and provide a brief description of the type of facility, its purpose, and the design approach used. Any sketches, data, and calculations that support the design and the criteria for the selection of materials and the location should be included in an appendix. (See Section 2.1 *Policies* and Section 2.3, *Hydraulics* for policy guidance and design criteria.)

- The Basis for Selecting Elevations for the Lowest Floor: Elevations must be selected to provide protection from flooding. The basis for the selection of a floor elevation or the design of protection for the interior of the building must be clearly presented (see Sections 2.1 and 2.3). Supporting documentation should be included in an appendix.

G. Conclusions
   - Overall Project
   - Description of the Provisions for Project Phasing:
     The phasing of parcels and the timing of the installation of drainage facilities should be described. Any project, particularly a large one, may have interim stormwater runoff, flooding, and erosion problems that would not exist after the project has been completed. The report must indicate how the phasing will occur, what interim drainage problems are anticipated, and what interim measures will be taken to protect against them.

2-203 METHODS FOR ESTIMATING PEAK DISCHARGE

A. Introduction
   Two methods are defined for the determination of peak discharges: the Rational Method, and rainfall-runoff modeling using the U.S. Army Corps of Engineers' HEC-1 Flood Hydrograph Package. For small watersheds less than 160 acres, the Rational Method is acceptable. For smaller watersheds that are non-uniform, irregular in shape, or when routing of flows is necessary, or for areas larger than 160 acres, HEC-1 modeling is required. Staff must approve of optional computer programs prior to preparation of the report.

The city's procedures are similar to those contained in the FCDMC's Hydrology Manual for Maricopa County. Scottsdale uses a six-hour duration storm event. However, Scottsdale uses the original source data, NOAA Atlas II for precipitation data, and the storm distribution pattern built in HEC-1. A detailed analysis of various methodologies conducted by Robert L. Ward tested and verified that the results using the following HEC-1 methods are comparable to those of the FCDMC and others.

B. Watershed Conditions

When a peak runoff flow rate is determined to size a drainage facility, or to determine the lowest floor elevation to protect a structure from flooding, the flow rate must be estimated by considering the watershed conditions that would produce the greatest peak flow rate. Usually a watershed which is fully developed in accordance with the city's General Plan Land Use Element will produce such conditions but other interim conditions such as the watershed's current state or its development in accordance with existing zoning may produce a greater peak flow rate and must be considered.

SPLIT-FLOW CONDITIONS:

Other considerations in north Scottsdale are upstream split flow channel conditions. These splits in the alluvial channels and highly erodible soils typical of north Scottsdale are generally unstable and very unpredictable. In setting finished floor elevations regarding upstream splits, it should be assumed that 100% of the flow could go either direction in any given flood event. For infrastructure design, the estimate of the actual split based on a hydraulic analysis of the current channel cross sections must include a minimum safety factor of 30 percent. If the designer feels that there are extenuating factors affecting the stability of the split in question the safety factor should be increased accordingly. The report should also include a brief description of all the assumptions made regarding watershed conditions used in the model or equations to calculate the peak flow rates.

C. The Rational Method

The Rational Method is limited to use on small, uniform, regularly shaped watersheds less than or equal to 160 acres in size.

$$Q = C\,I\,A\,f$$

Q = the instantaneous peak flow or discharge rate in cubic feet per second
C = a dimension-less runoff coefficient (Figure 2.2-17)
I = rainfall intensity in inches per hour

Caution

Rainfall Intensity is a rate, not the total depth of rainfall for a given duration storm

A = contributing drainage or watershed area in acres
f = frequency adjustment factor (per FCDMC, Hydrology Manual, 6-92)

The Rational Method only generates a peak discharge flow rate. It cannot be used to determine runoff volumes. HEC-1 is recommended if runoff volume is needed. Calculations must be submitted using Figure 2.2-18, or a similar form containing the same data and information. Frequency adjustment factors are included in Figure 2.2-18.

PRECIPITATION

Precipitation input is "*rainfall intensity,*" **I**. It is obtained directly from Figure 2.2-13, which applies citywide. The time of concentration, **Tc**, is all that is required to determine **I** from Figure 2.2-13.

TIME OF CONCENTRATION

Time of concentration, **Tc**, is the total time of travel from the most hydraulically remote part of the watershed to the concentration point of interest. Figures 2.2-14 and 2.2-15 can be used to estimate flow velocity for calculating the time of travel. Procedures from Chapter 3 of SCS's TR-55, contained in Appendix B, are recommended for determining **Tc**. The minimum time of concentration that should be used is five minutes.

Do not add a standard set amount of time to the estimated Tc for lot runoff delay (such as 5 or 10 minutes). Natural land slopes are too variable in Scottsdale to add a set amount of time for lot runoff. Analyze delays from lot runoff as overland flow or sheet flow. Use the size and slope of the lot to determine the actual time of travel across the lot.

RUNOFF COEFFICIENTS

Figure 2.2-17 must be used to obtain the runoff coefficients, or **C** values. Composite **C** values for the appropriate zoning category or weighted average values calculated for the specific site, are both acceptable approaches.

CAUTION

HEC-1 computer program or equivalent computer programs should be used instead of the Rational Method on areas greater than 40 acres in size if the watershed is non-uniform or irregular in shape. HEC-1 or its equivalent must be used if the routing of flows is necessary.

D. The Corps of Engineer's HEC-1 Computer Model

HEC-1 procedures are applicable for any watershed area over 40 acres and up to 100 square miles in size. HEC-1 is required for analyzing drainage areas over 160 acres in size. **HEC-HMS is not an acceptable substitute for HEC-1**. Minimum required submittals when using HEC-1 are:

1. A printout of the input data,
2. A schematic (routing) diagram of the stream network,
3. The runoff summary output table, and
4. A diskette with the input file(s).

PRECIPITATION The required precipitation input is the six hour duration storm using the model's built in hypothetical storm distribution pattern and is input using the PH record. Precipitation values are to be obtained from the Isopluvial maps (Figures 2.2-1 through 2.2-2) for the specific frequency desired. The 5, 15, 60, 120, 180, and 360 (6-hour) minute duration rainfall amounts should be calculated per the formula and procedures in Appendix A.

INFILTRATION: Infiltration or soil losses can be determined using SCS Runoff Curve Numbers (use Figures 2.2-19 and 2.2-20) or Green and Ampt (G&A) procedures per FCDMC Hydrology Manual. Use the most recent published SCS soil survey maps of the area to determine the hydrologic soil group or surface soil texture for the G&A procedures. Use USDA Soil Conservation Services maps, Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, or the Soil Survey of Eastern Maricopa and Northern Pinal Counties, Arizona, depending on what part of the city you are located. The simplified map in Figure 2-14 of the previous Design Standards and Policies Manual is not sufficiently detailed and is superseded by the above soil maps.

RUNOFF CURVE NUMBERS: When using runoff curve numbers (ROCN) within the city of Scottsdale one must:

- Assume poor hydrologic condition and desert shrub cover type for natural undisturbed desert conditions in Figure 2.2-20.

- For lawns, golf courses, and other grassed open space areas, assume good condition in Figure 2.2-19 to determine the ROCN, then adjust the ROCN to antecedent moisture condition III (use Figure 2.2-21).

- For developed conditions, increase the percent impervious on the LS card without changing the ROCN (except in the case of grassed areas, in which the curve number should be adjusted up according to the above). Obtain the percent impervious from Figure 2.2-16 for residential districts or use actual amount. For commercial or industrial districts use the actual or estimated percent impervious. A minimum of 85 percent for commercial and 72 percent industrial must be used.

HYDROGRAPH GENERATION Small basin or sub-watershed hydrographs can be generated using the SCS dimensionless unit hydrograph procedure or kinematic wave method as described in the HEC-1 Users Manual. Computation time interval should generally range from 5 to 1 minute.

TIME OF CONCENTRATION (**Tc**) Use the estimated time of travel, from the most hydraulically remote part of the watershed to the concentration point. The procedures from Chapter 3 of SCS's TR-55 (contained in Appendix B) are recommended for obtaining **Tc**.
CAUTION: For the SCS method, remember TLAG on the UD input card is equal to 0.6(**Tc**), not **Tc**.

CHANNEL ROUTING Channel routing should use the Normal Depth (Modified Puls), eight point routing procedure as described in the HEC-1 Users Manual.
CAUTION: For the 1990 version of the HEC-1 program, do not use the kinematic wave method with the multi-ratio JR cards because the hydrographs do not combine properly. For the 1988 version, do not use JD cards with the Green-Ampt method, as errors will result. HEC-1 versions prior to the 1988 version will not be accepted.

E. Pre- versus Post-Development Discharge Analysis Procedures
The following HEC-1 analysis procedures must be used when it is necessary to establish a comparison of pre-development to post-development discharge (runoff) conditions.

1. The HEC-1 modeling procedures described in Section 2-203 must be followed.

2. Reflect fully developed conditions per section 2-203C.3, by:

   a. Increasing the percent impervious on the LS card to reflect the amount of impervious surfaces that will exist under fully developed conditions.

   b. Recalculate the time of concentration (**Tc**) based on the proposed drainage system, after full development. Normally there should be a reduction in **Tc** after development.

3. The existing condition model must be sub-divided, as necessary, to create concentration points which will match the subwatershed areas above each proposed storage facility under fully developed conditions.

4. Each separate storage facility proposed must be modeled as it will physically exist under fully developed conditions with appropriate routing and combining operations through each basin and through the entire watershed. The modeling of storage capacity provided, as one hypothetical reservoir at the outlet with all the upstream storage arbitrarily combined at this one location, is not acceptable.

5. As a minimum the 2, 10 and 100-year frequency events must be analyzed.

6. Comparison of discharge values for existing and post development conditions must be made at concentration points just downstream from each proposed storage facility; other critical locations such as road crossings; and at points where flows exit the proposed development.

2-204 CALCULATION OF RUNOFF VOLUMES

The only method for the determination of the required volume of stormwater storage is the standard formula described in Section 2-204 A. HEC-1 modeling can be used for storage basin design and analysis (see Section 2-204 B) or if a pre-versus post volume difference is needed. The current citywide ordinance requirement is to provide on-site storage for runoff from the 2-hour 100-year frequency event, as described below, and in Section 2.1 of the Design Standards and Policies Manual.

A. Standard Formula

Vr = (P/12) AC

Vr = Required storage volume in acre-feet.
P = Precipitation amount = 2.82 inches. The average depth of the 100 year 2 hour duration rainfall.(applies citywide).
A = Area in acres; the developed portion of the entire site in acres, to the centerline of adjacent streets, on which any man-made change is planned, including, but not limited to: construction, excavation, filling, grading, paving, or mining. See the Stormwater Storage Policy Statement in Section 2.1.
C = Runoff coefficient; Rational Method values from Figure 2.2-17, either composite or weighted can be used.

B. HEC-1 Computer Modeling

The HEC-1 model, or similar computer program, is not to be used to determine the ordinance required 2-hour 100-year stormwater storage runoff volumes. The HEC-1 program is, however, recommended for use in storage routing for storage basin design and analysis purposes; or for a pre versus post analysis (which must use a six hour storm and procedures described under Section 203). Use modified Puls level pool routing option in HEC-1 for hydrograph routing through storage basins and lakes. For permanent lakes, assume no available storage below the normal water surface elevation.

CAUTION: Do not use the built-in orifice equation in the HEC-1 model because errors can result. It is necessary to build a stage discharge table and input to the model.

2-205 MASTER DRAINAGE PLAN CHECK LIST

This checklist is to assist in submitting a complete and successful Master Drainage Plan to the city of Scottsdale. The following items on this list are required with the submittal.

Master Plan #_____ --MP-- _____ Title:_____

PART I - GENERAL REQUIREMENTS

1. Master Drainage Plan Check List (this list).
2. Master Plan Review Fee: $_____.
3. Six (6) copies of the approved Master Drainage Plan Report, two (2) copies to initiate the review process.

PART II - REQUIRED PLANS AND RELATED DATA

Each Master Drainage Plan Report submittal shall include the following items:

DESCRIPTION OF PROJECT

1. Project Name.
2. Location.
3. Description of the type and scope of project.
4. Size.
5. Vicinity Map.

DESCRIPTION OF ON-SITE DRAINAGE CHARACTERISTICS

1. COS Drainage Aerial Photograph 400 scale, (clearly identifying project location) - 30" x 30".
2. Topographic Map, 100 scale, one foot contour interval, 24" x 36".
3. Show key concentration points with Q100 year peak discharges.
4. Show watershed boundaries.
5. Show floodplain boundaries for all washes were Q100 year is 250 cfs or greater.
6. Describe existing onsite drainage characteristics.

DESCRIPTION OF OFF-SITE WATERSHED CONDITIONS

1. Aerial photos, city 800 scale.
2. City GIS 2 ft. contour interval topographic maps.
3. Show drainage concentration points entering and leaving the project site.
4. Describe existing drainage conditions and characteristics and any future planned projects.
5. Describe relation to existing Master Plans and adjacent drainage plans.

PROPOSED MASTER DRAINAGE PLAN

1. Proposed on-site drainage plan: Scale one inch equals 100 feet, one foot contour intervals, 24" x 36".
2. Site development plan 24" x 36".
3. Show peak discharge values Q100 year at key concentration points.
4. Show and describe major drainage structures or special drainage facilities needed.
5. Describe proposed drainage system and components, including design criteria and probable effect on the existing upstream and downstream drainage system.

6. Describe ordinance stormwater requirements, volume required, volume provided, and location.

DATA ANALYSIS METHODS

1. Describe hydrologic procedures and assumptions.
2. Describe hydraulic procedures, and assumptions.
3. Describe stormwater storage calculation methods and assumptions.

DATA AND CALCULATIONS

1. Peak flow calculations (Figure 2.2-18 data records; or HEC- I printouts).
2. Channel design calculations.
3. Culvert design calculations.
4. Floodplain calculations (Manning's or HEC-2 printouts).
5. Storage volume calculations.
6. Retention/detention basin inflow-outflow analysis and design calculations.

PART III - MASTER DRAINAGE PLAN REPORT FORMAT

The following chapters should include the data and exhibits listed above in Part II. See 2-202 and 2-205 in section 2.2 of the city's Design Standards and Policies Manual for additional guidance for Report Preparation.

1. Project Description.
2. On-site Drainage Characteristics.
3. Off-site Watershed Conditions.
4. Proposed Master Drainage Plan.
5. Project Phasing Plan.
6. Data and Calculations (Appendixes).

APPENDIX

Data and Calculations (as applicable):

- Peak Flow Calculations (Figure 2.2-18, Data Records; or HEC-1 printouts)
- Channel Design Calculations
- Culvert Design Calculations
- Floodplain Calculations (Manning's, HEC-2, or HECRAS printouts)
- Storage Volume Calculations
- Retention/ Detention Basin Inflow-Outflow Analysis and Basin Design Calculations.
- Street Capacity Calculations
- Curb Opening, Catch Basin Calculations
- Storm Drain Calculations
- Sediment and Scour Calculations
- Rip-Rap Sizing
- Finished Floor Elevations:
  Basis for setting finished floor elevations:
  - In relation to designated floodplains or adjacent washes;
  - In relation to natural or adjacent ground elevation if in an AO Zone or not in floodplain.
- Erosion/ Sediment Control Plan
- Soils and or Geologic Analyses
- Special Problem Calculations

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APPENDIX A

Steps for Determination of Precipitation Values for Various Durations and Return Periods

APPENDIX A

Steps for Determination of Precipitation Values for Various Durations and Return Periods.

Step 1: From the precipitation maps, Figures 2.2-1 through 2.2-12, determine the precipitation values for the six and twenty four hour duration storms for return periods of 2, 5, 10, 25, 50, and 100 years. Tabulate these values in Table 1 in the column headed "Map Values."

Table 1

Return Period (Years)	Precipitaton Values (Inches)			
	6 hour duration		24 hour duration	
	Map Value	Corrected Value	Map Value	Corrected Value
2				
5				
10				
25				
50				
100				

NOTE: There is a possibility of making an error while reading the maps because: (1) a site is not easy to locate precisely on a series of 12 maps, (2) there may be some slight registration differences in printing, and (3) precise interpolation between isolines is difficult. In order to minimize any errors in reading the maps, these values should be plotted on the diagram "Precipitation Depth versus Return Period," Appendix A, Figure 1.

Step 2: Plot these values on the diagram "Precipitation Depth versus Return Period," Appendix A, Figure 1.

Step 3: Draw a line of best fit through the 6 hour precipitation values and another line through the 24-hour precipitation values.

Step 4: Tabulate the values represented by the lines of best fit, obtained in Step 3, in the column of Table I entitled "Corrected Value."

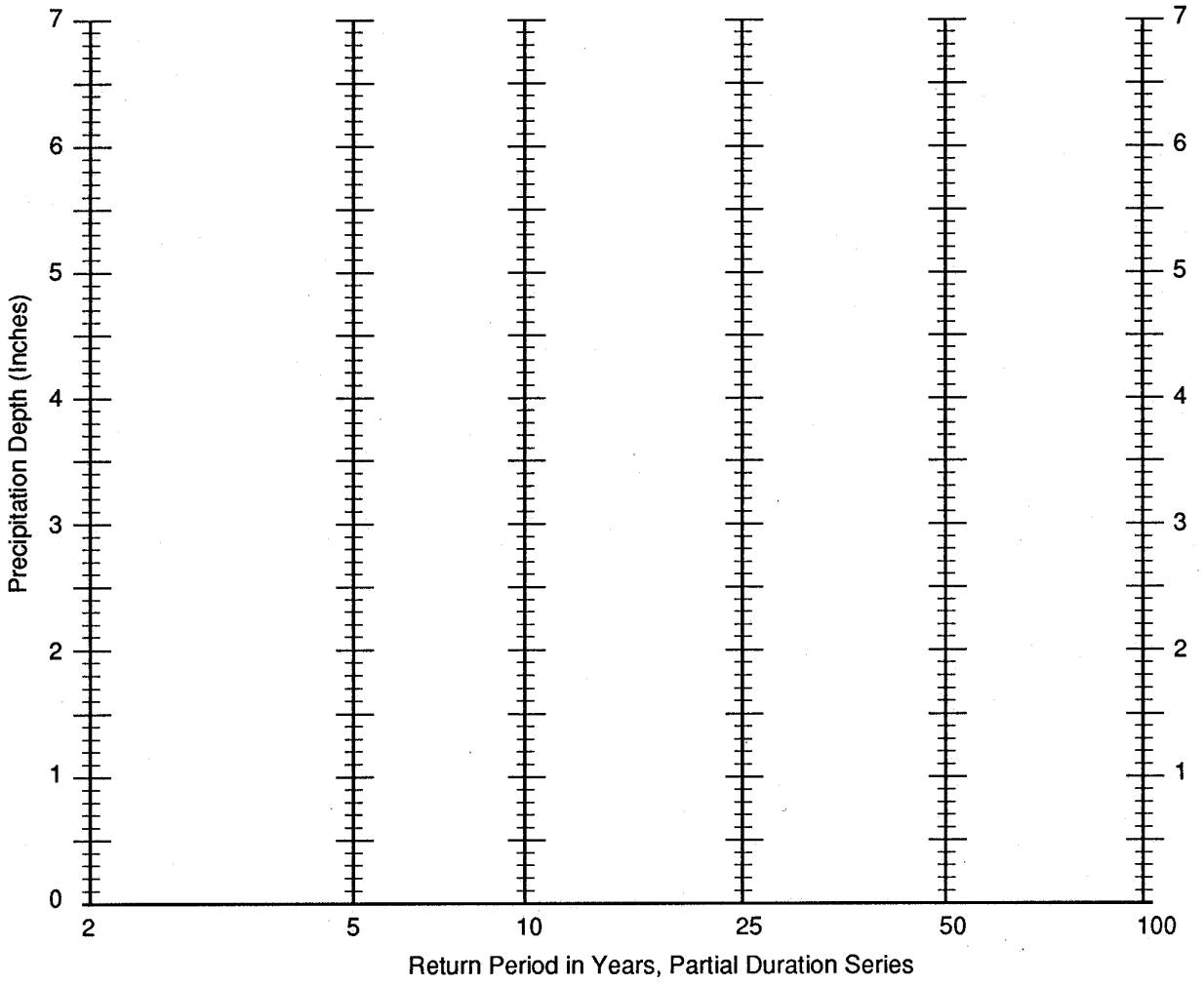
NOTE: The 1 hour precipitation value is needed to determine the 2 and 3 hour values as well as the 5, 10, 15, and 30 minute values.

Sheet 1 of 3

(Source: Addendum to "Hydrologic Design for Highway Drainage in Arizona," April 1975, and ADOT, April 17,1987)

APPENDIX A (con't)

Figure 1. Precipitation Depth versus Return Period for Partial Duration Series



Project: _____ Station: _____

Sheet 2 of 3

(Source: Addendum to "Hydrologic Design for Highway Drainage in Arizona," April 1975)

APPENDIX A (con't)

Steps for Determination of Precipitation Values for Various Durations and Return Periods.

Step 5: Using the 6 and 24 hour values for the 2 year and 100 year return periods, from Table 1 (corrected values), solve the following equations to determine the 1 hour values:

$$Y_2 = -0.011 + 0.942(X_1^2 / X_2)$$

$$Y_{100} = 0.494 + 0.755(X_3^2 / X_4)$$

Where: Y_2 = 2 year 1 hour value
Y_{100} = 100 year 1 hour value
X_1 = 2 year 6 hour value from Table 1
X_2 = 2 year 24 hour value from Table 1
X_3 = 100 year 6 hour value from Table 1
X_4 = 100 year 24 hour value from Table 1

Step 6: To determine 1 hour precipitation values for the other return periods, first plot the 2 year 1 hour value and the 100 year 1 hour value on Figure 1. Connect the two points by a straight line. The values on this line will give the 1 hour precipitation values for the various return periods.

Step 7: To determine the 2 and 3 hour precipitation values, use the following formula with data far the appropriate return period from Table 1 (corrected values):

$$P_{2\ hour} = 0.341\ (P_{6\ hour}) + 0.659\ (P_{1\ hour})$$
$$P_{3\ hour} = 0.569\ (P_{6\ hour}) + 0.431\ (P_{1\ hour})$$

Step 8: The 12 hour precipitation value for any return period is determined by the following equation:

$$P_{12hr} = 0.49\ P_{24\ hour} + 0.51\ P_{6\ hour}$$

Step 9: To determine precipitation values for durations less than 1 hour for any return period, multiply the 1 hour depth by the following ration:

Duration (minutes) :	5	10	15	30
Ratio to one hour*:	.34	.51	.62	.82

*From Arkell and Richards (1986) per FCDMC's Hydrology Manual (9-90)

Sheet 3 of 3

(Source: Addendum to "Hydrologic Design for Highway Drainage in Arizona," April 1975, and ADOT April 17,1987)

APPENDIX B

Time of Concentration and Travel Time: SCS TR55 Procedure

APPENDIX B

Time of Concentration and Travel Time: SCS TR55 Procedure

Introduction

Travel time (Tt) is the time it takes water to travel from one location to another in a watershed. Tt is a component of time of concentration (Tc), which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. TC is computed by summing all the travel times for consecutive components of the drainage conveyance system. Tc influences the shape and peak of the runoff hydrograph. Urbanization usually decreases Tc, thereby increasing the peak discharge. But Tc can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

Factors affecting time of concentration and travel time

Surface roughness: One of the most significant effects of urban development on flow velocity is less retardant to flow. That is undeveloped areas with very slow and shallow overland flow through vegetation be come modified by urban development: the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns: In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope: Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decreased when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time and time of concentration

Water moves though a watershed as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600\ V} \quad \text{(Eq. \#1)}$$

Where:
T_t = travel time (hr.),
L = flow length (ft.),
V = average velocity (ft/s), and
3600 = coversion factor from seconds to hours.

Time of concentration (T_c) is the sum ot T_t values for the various consecutive flow segments:

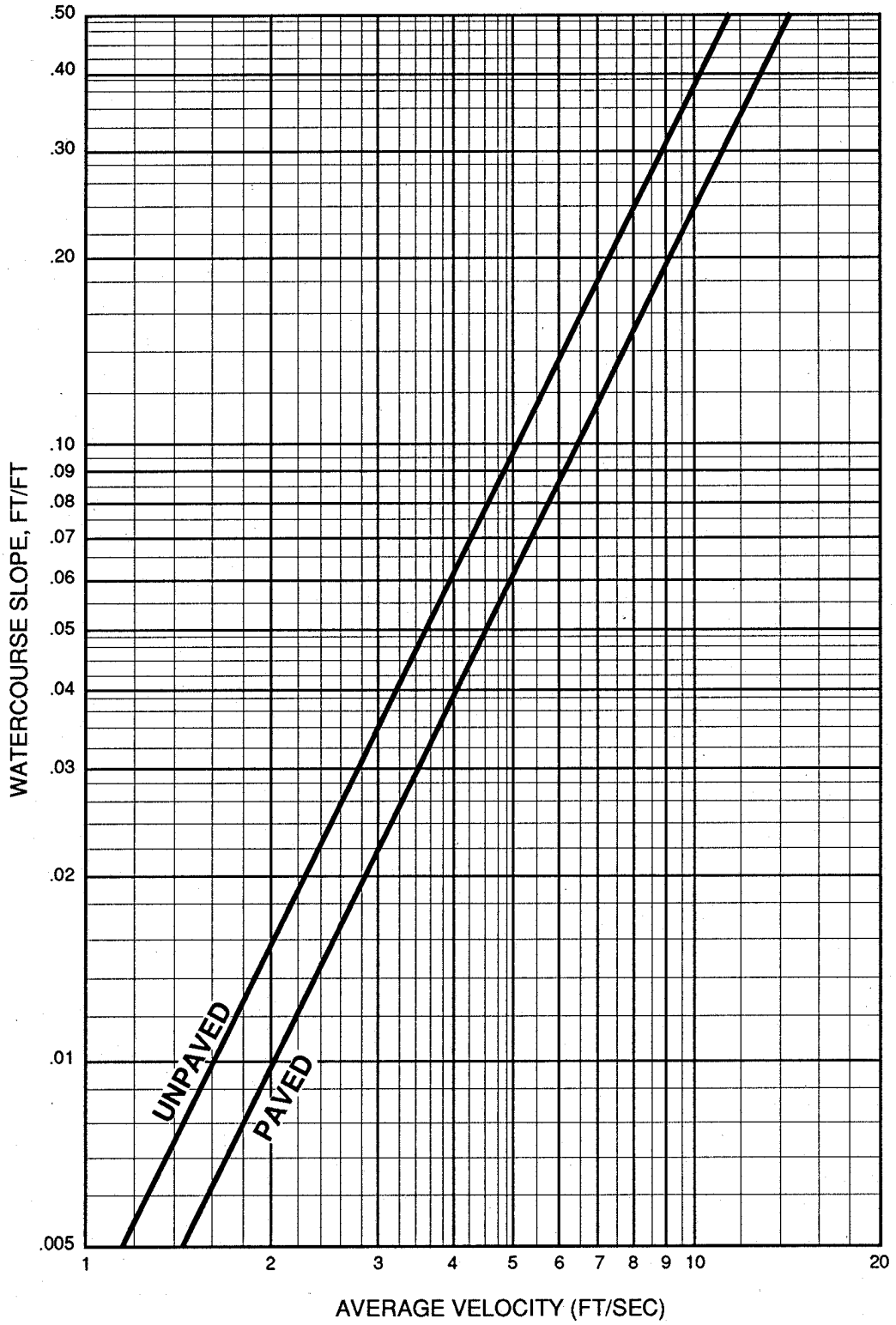
$$Tc = T_{t1} + T_{t2} + \ldots T_{tm} \quad \text{(Eq. \#2)}$$

Where:
T_c = time of concentration (hr) and
m = number of flow segments.

Sheet 1 of 4

APPENDIX B (con't)

Figure B-1. Average Velocity for Estimating Travel Time for Shallow Concentrated Flow



Source: TR-55, Fig. 3-1

Sheet 2 of 4

APPENDIX B (con't)

Time of Concentration and Travel Time: SCS TR55 Procedure

Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. Use Figure 2.2-14 to compute the travel time (Tt) for sheet flow, maximum length of is flow is 300 feet.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from Figure B-1, in which average velocity is a function of watercourse slope and type of channel. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in Figure B-1, use equation #1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation (assume 10 year frequency event in Arizona desert).

APPENDIX B (con't)

Time of Concentration and Travel Time: SCS TR55 Procedure

Manning's equation is:

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n} \quad \text{(Eq.\#4)}$$

Where:
V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/p_w
a = cross sectional flow area (ft^2)
p_w = wetted perimeter (ft)
s = slope of the hydraulic grade line (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1959) or Linsley et al. (1982). After average velocity is computed using equation #4, T_t for the channel segment can be estimated using equation #1.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.

Limitations

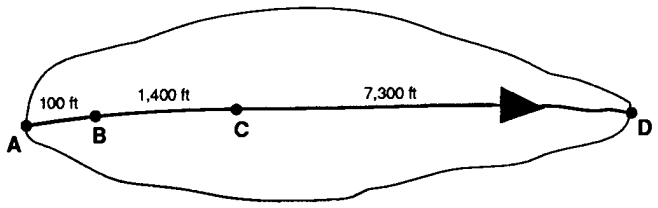
- Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation #3 was developed for use with the four standard rainfall intensity-duration relationships (used in TR-55).

- In watersheds with storm sewers, carefully identify the appropriate hydraulic flow path to estimate T_C. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or nonpressure flow.

- The minimum T_C used in TR-55 is 0.1 hour.

Example

The sketch below shows a sample watershed. The problem is to compute T_C at the outlet of the watershed (point D). All three types of flow (overland sheet flow, shallow concentrated flow, and channel flow) occur from the hydraulically most distant point (A) to the point of interest (D). To compute T_C, first determine T_t for each segment, then sum all three T_t's to obtain the watershed or sub-area T_C.



APPENDIX C

Precipitation Frequency Maps
Figures 2.2-1 through 2.2-12

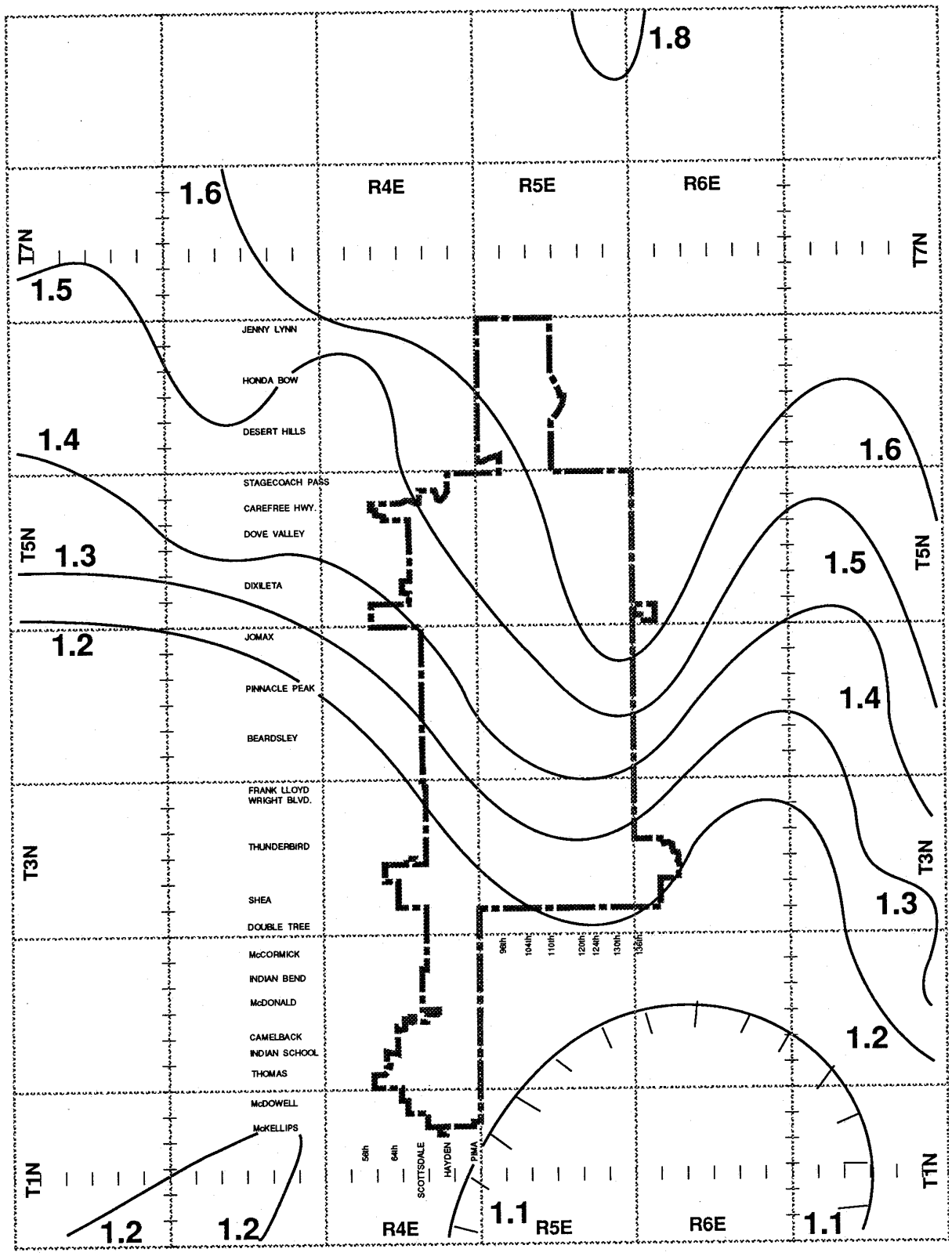


FIGURE 2.2-1

Isopluvials 2 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

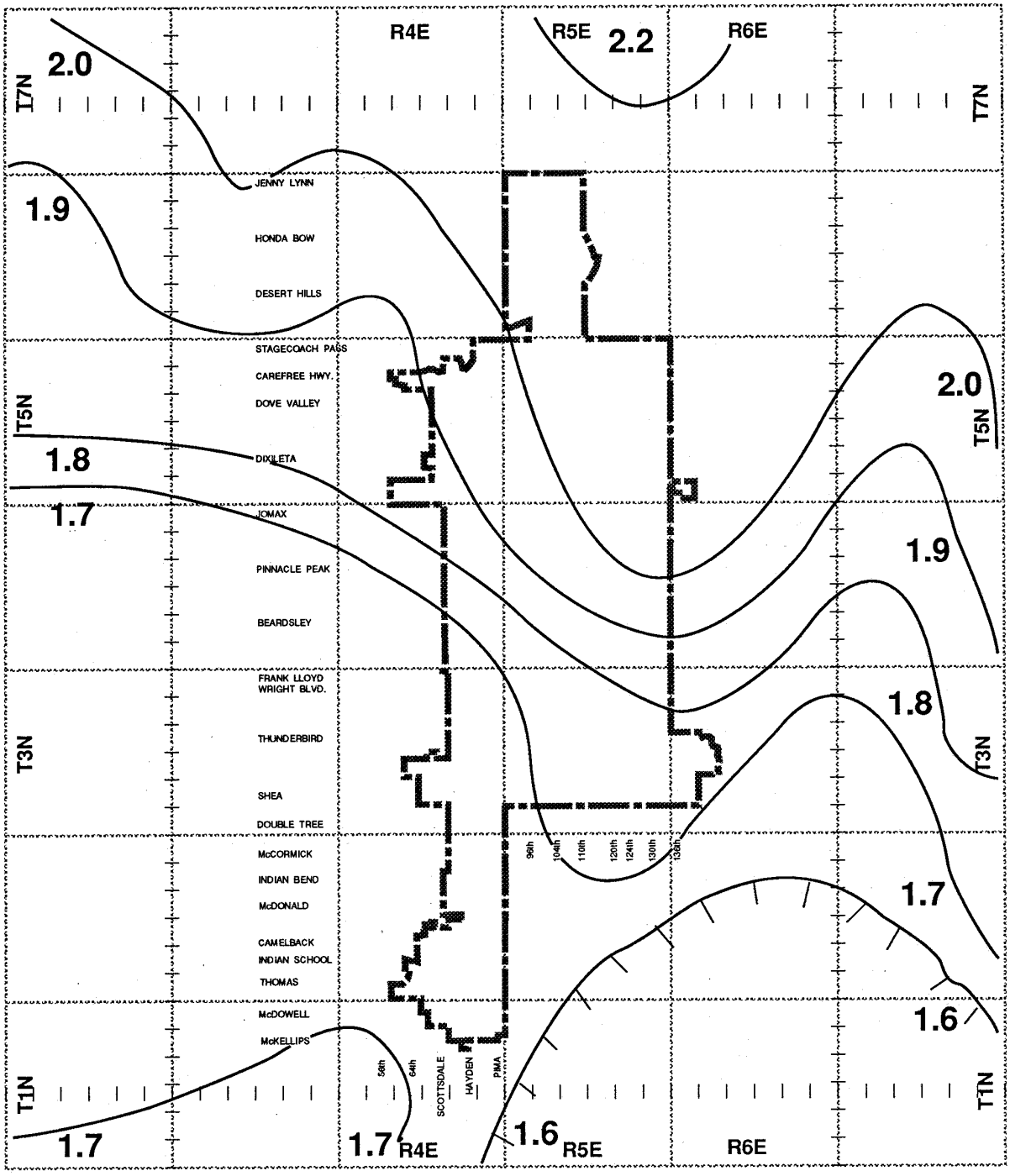


FIGURE 2.2-2

Isopluvials 5 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

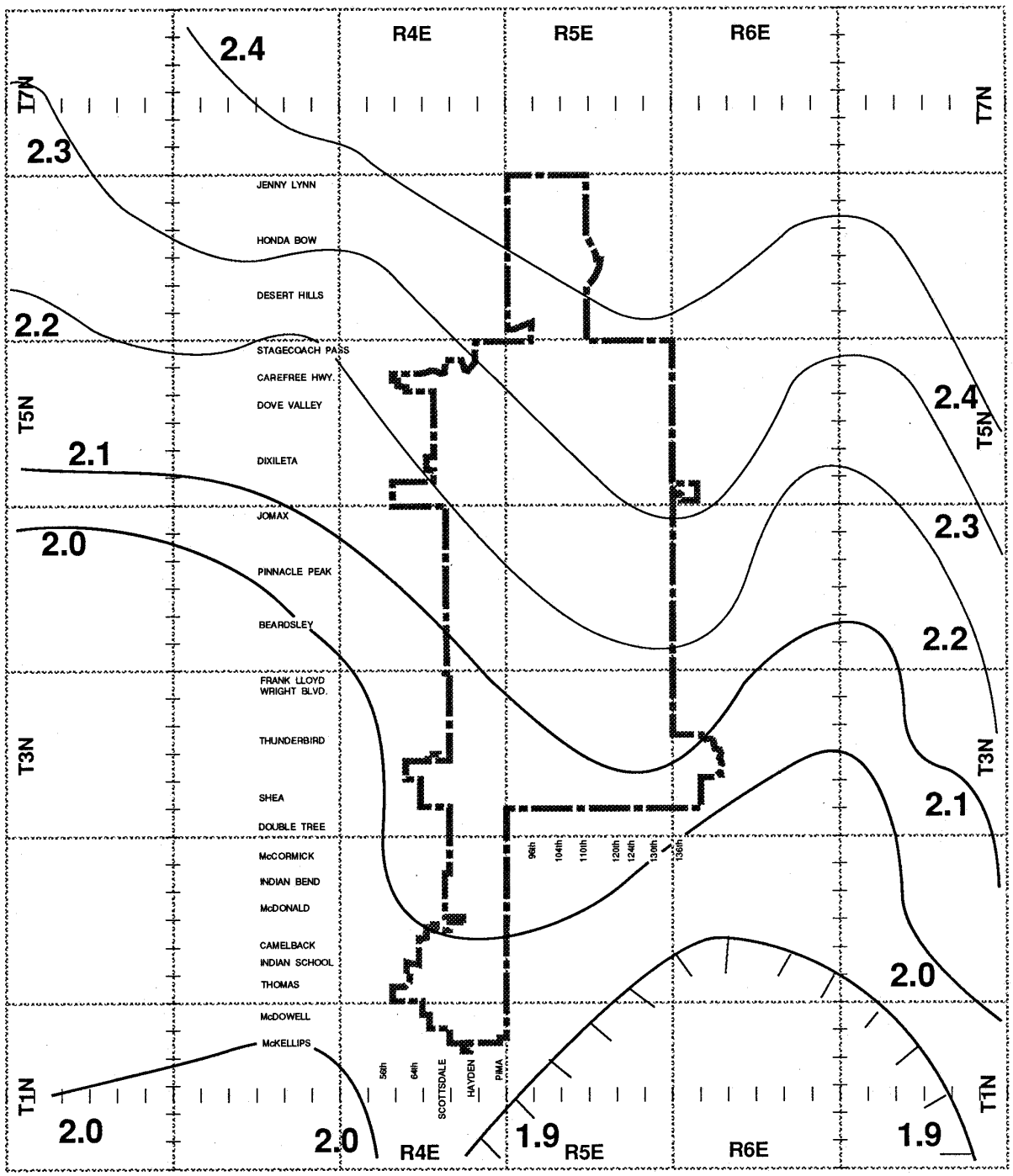


FIGURE 2.2-3

Isopluvials 10 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

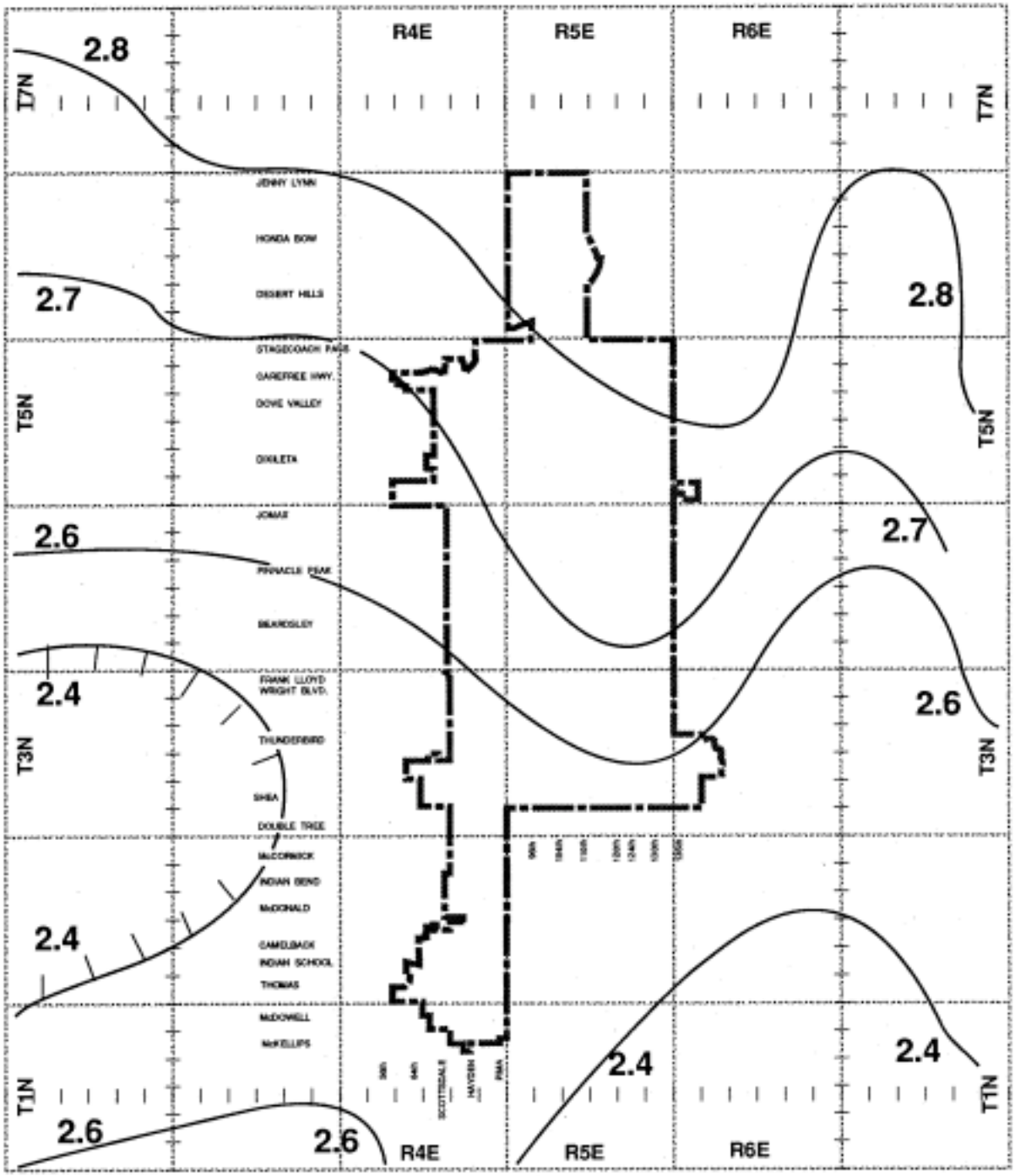


FIGURE 2.2-4

Isopluvials 25 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

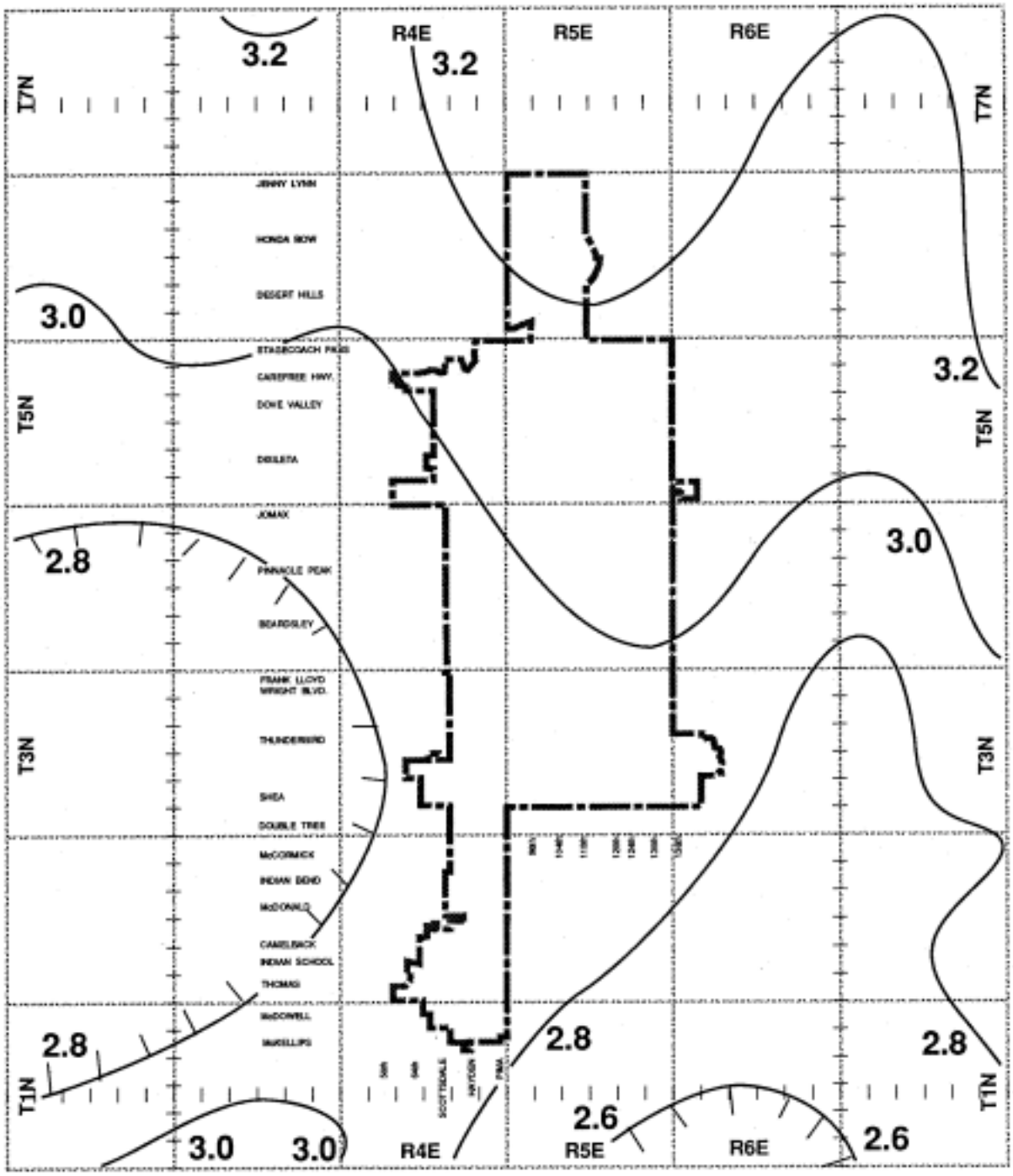


FIGURE 2.2-5

Isopluvials 50 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

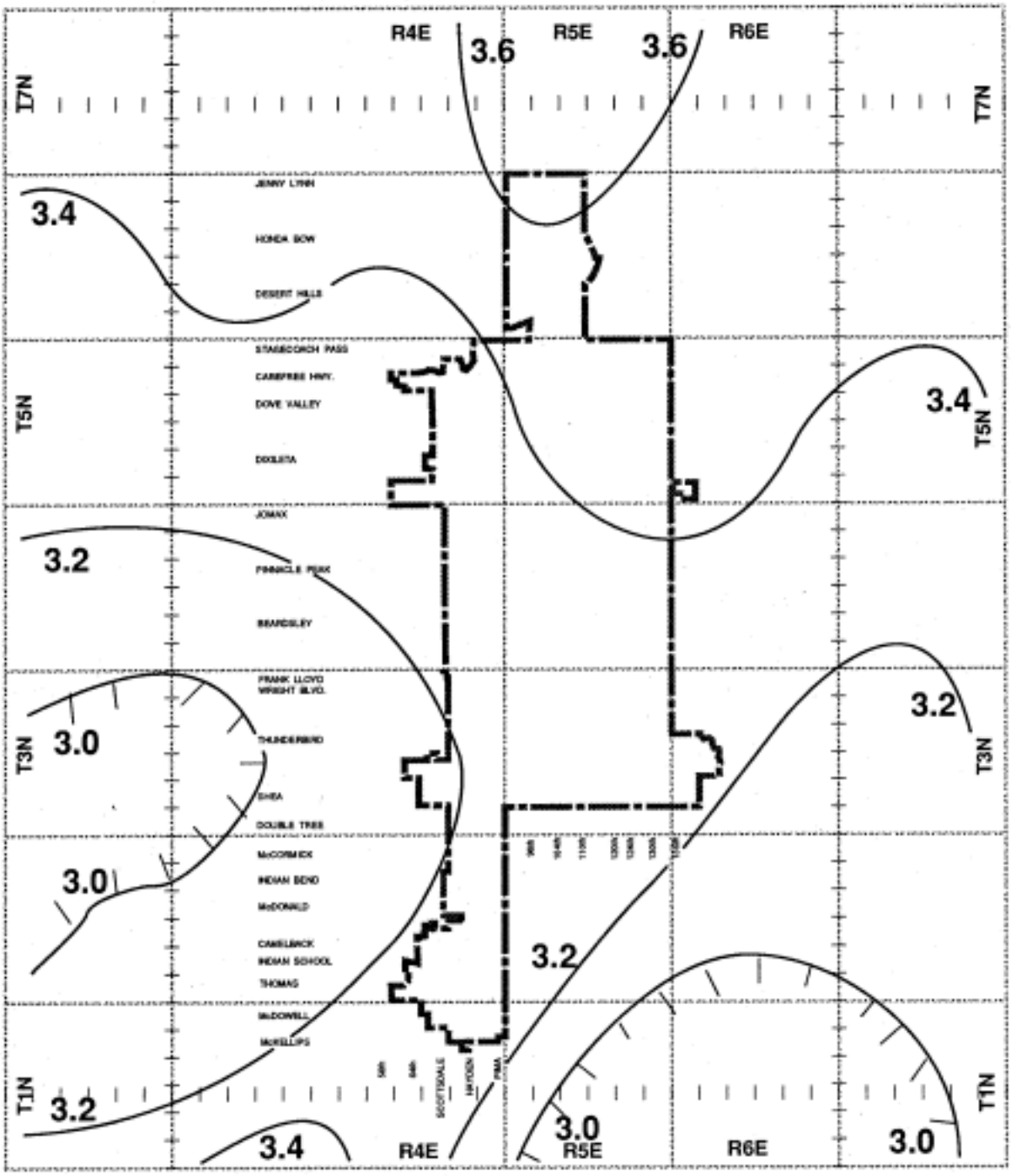


FIGURE 2.2-6

Isopluvials 100 Year 6 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

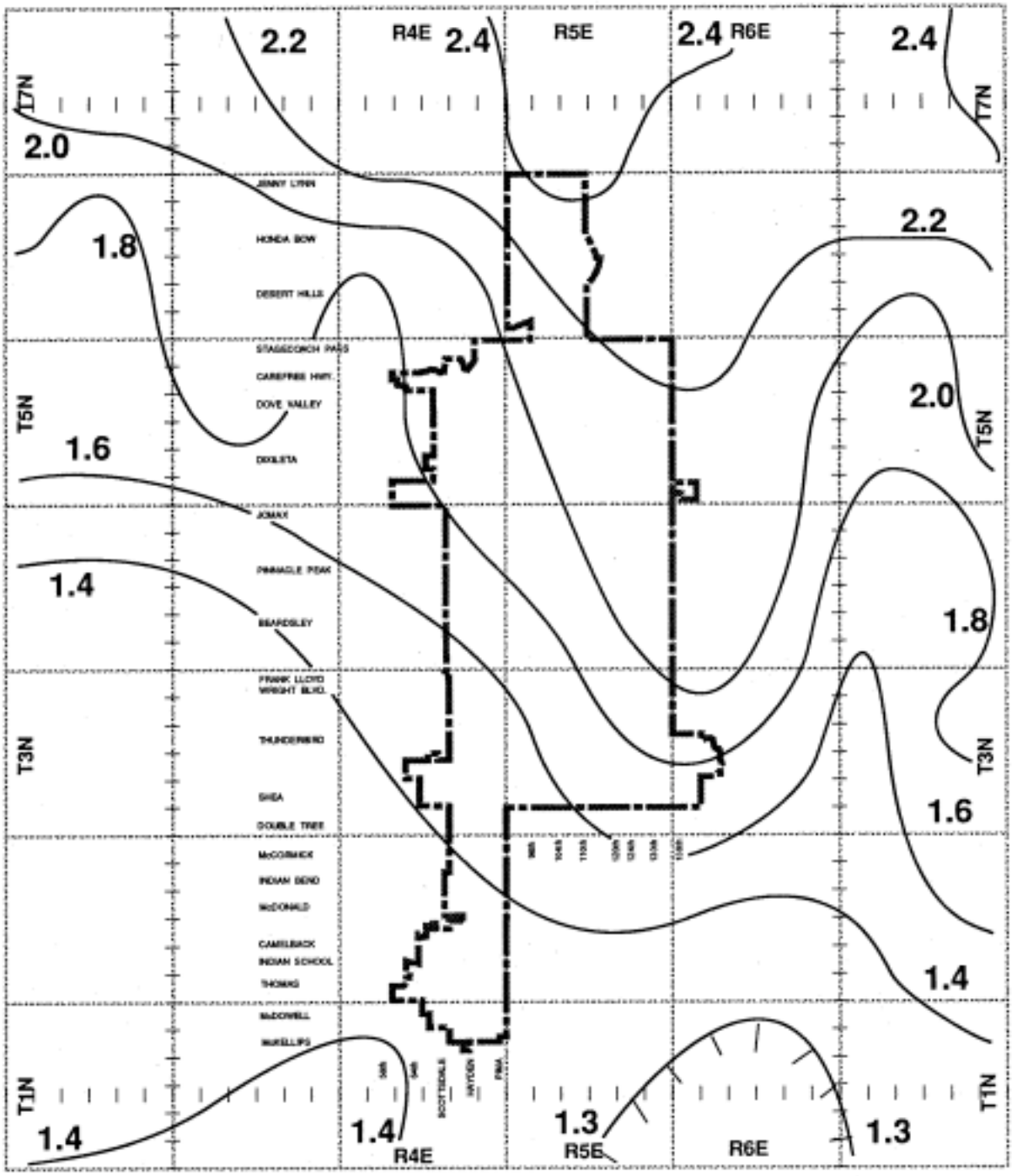


FIGURE 2.2-7

Isopluvials 2 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

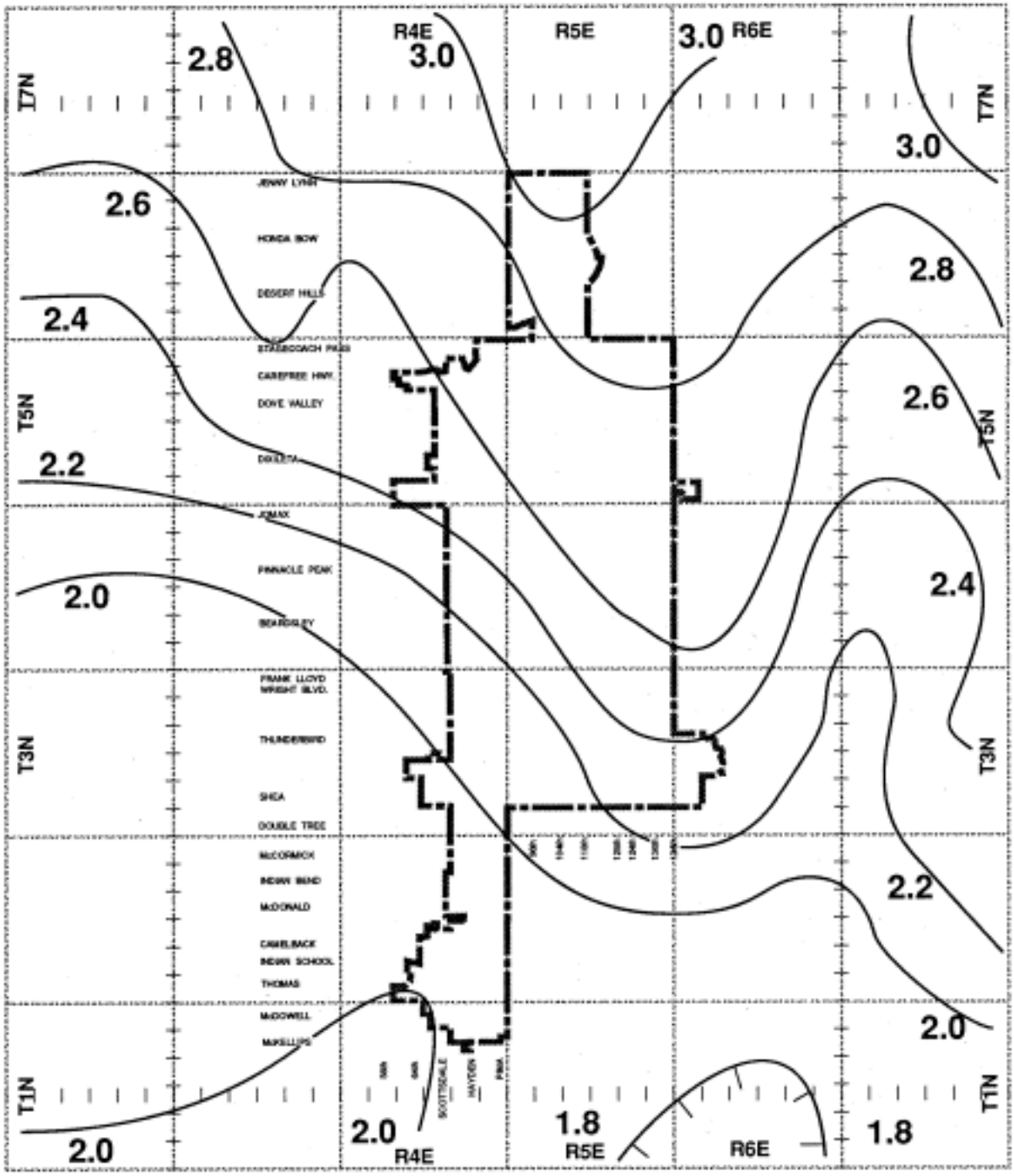


FIGURE 2.2-8

Isopluvials 5 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

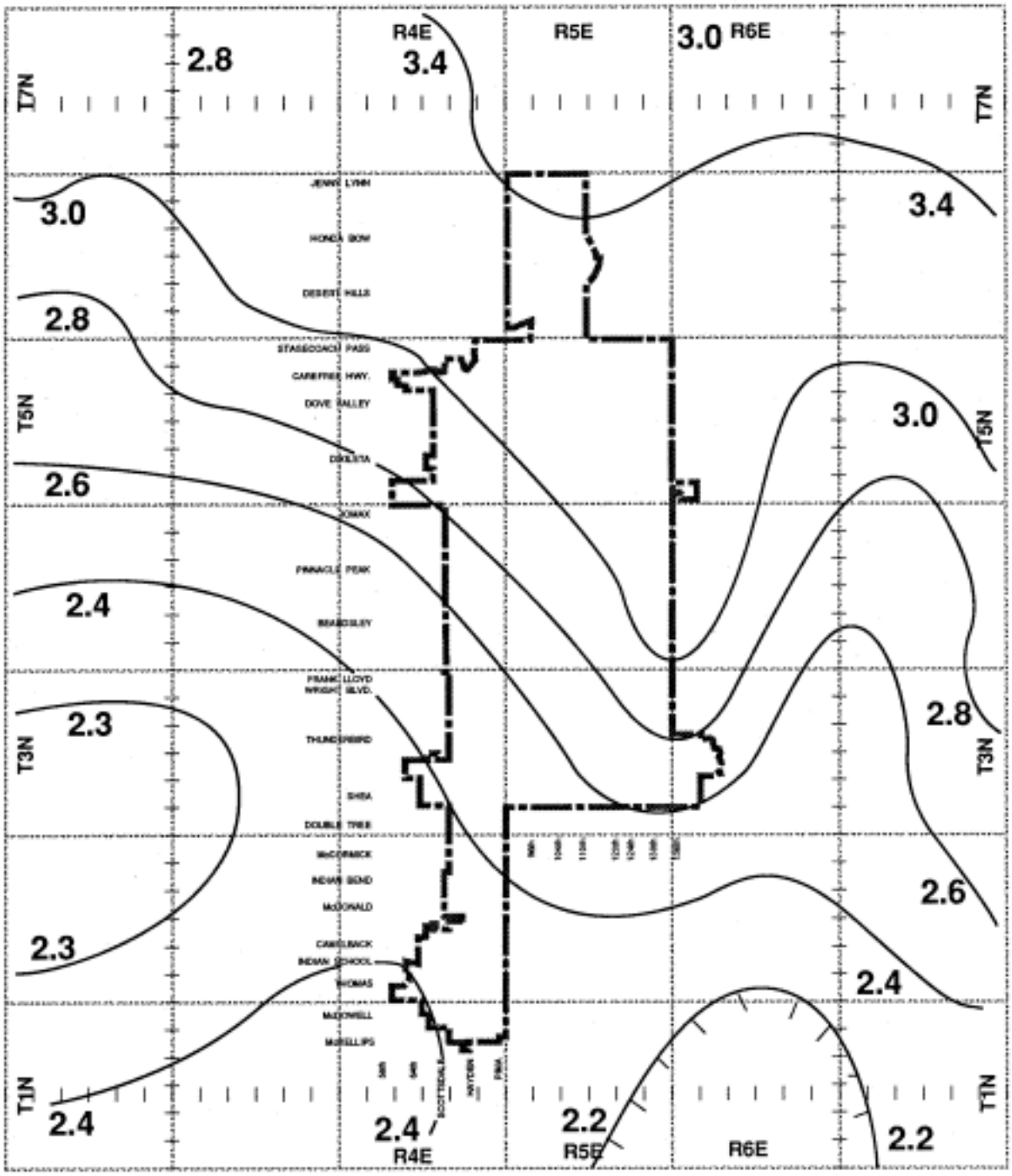


FIGURE 2.2-9

Isopluvials 10 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

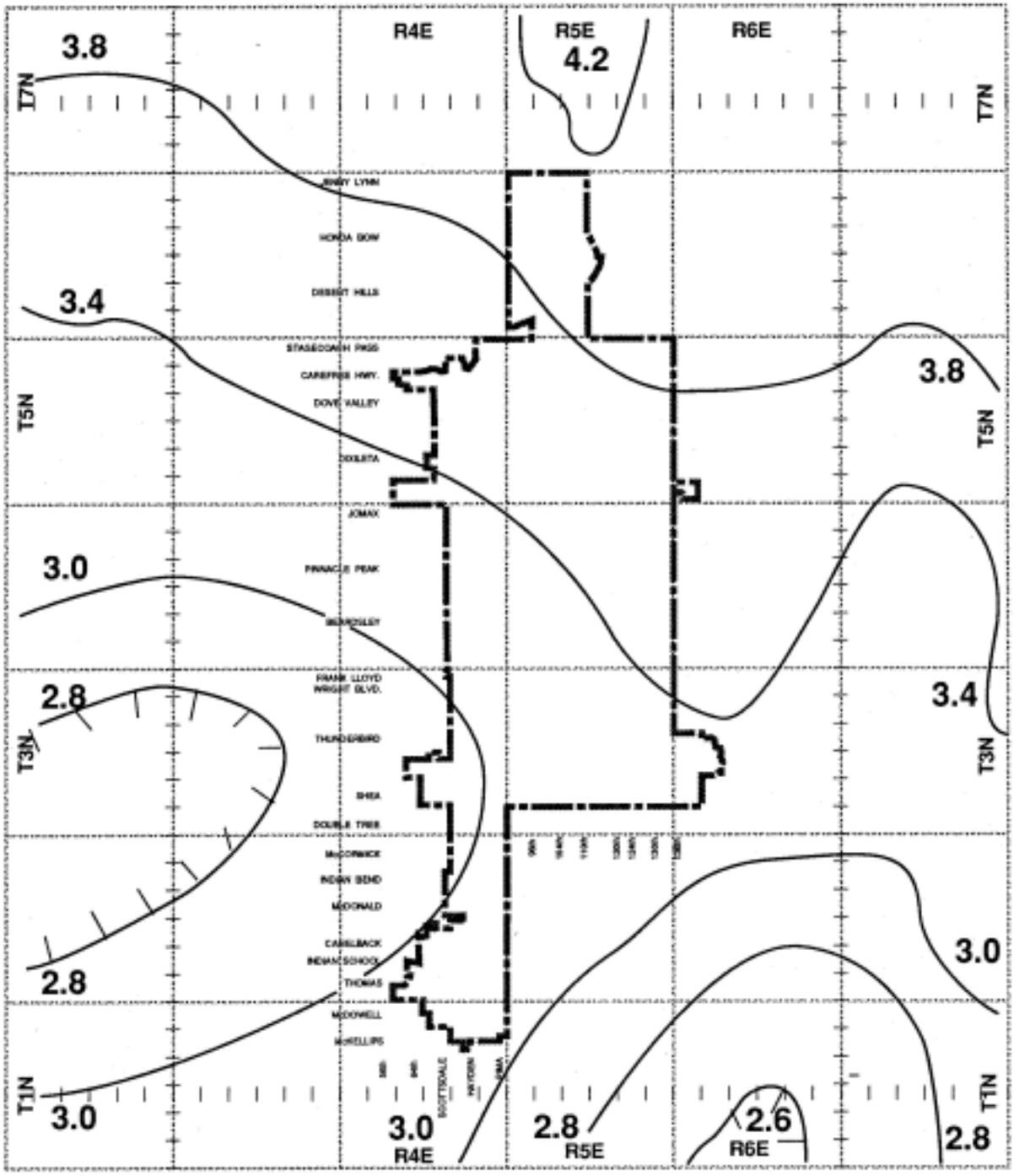


FIGURE 2.2-10

Isopluvials 25 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

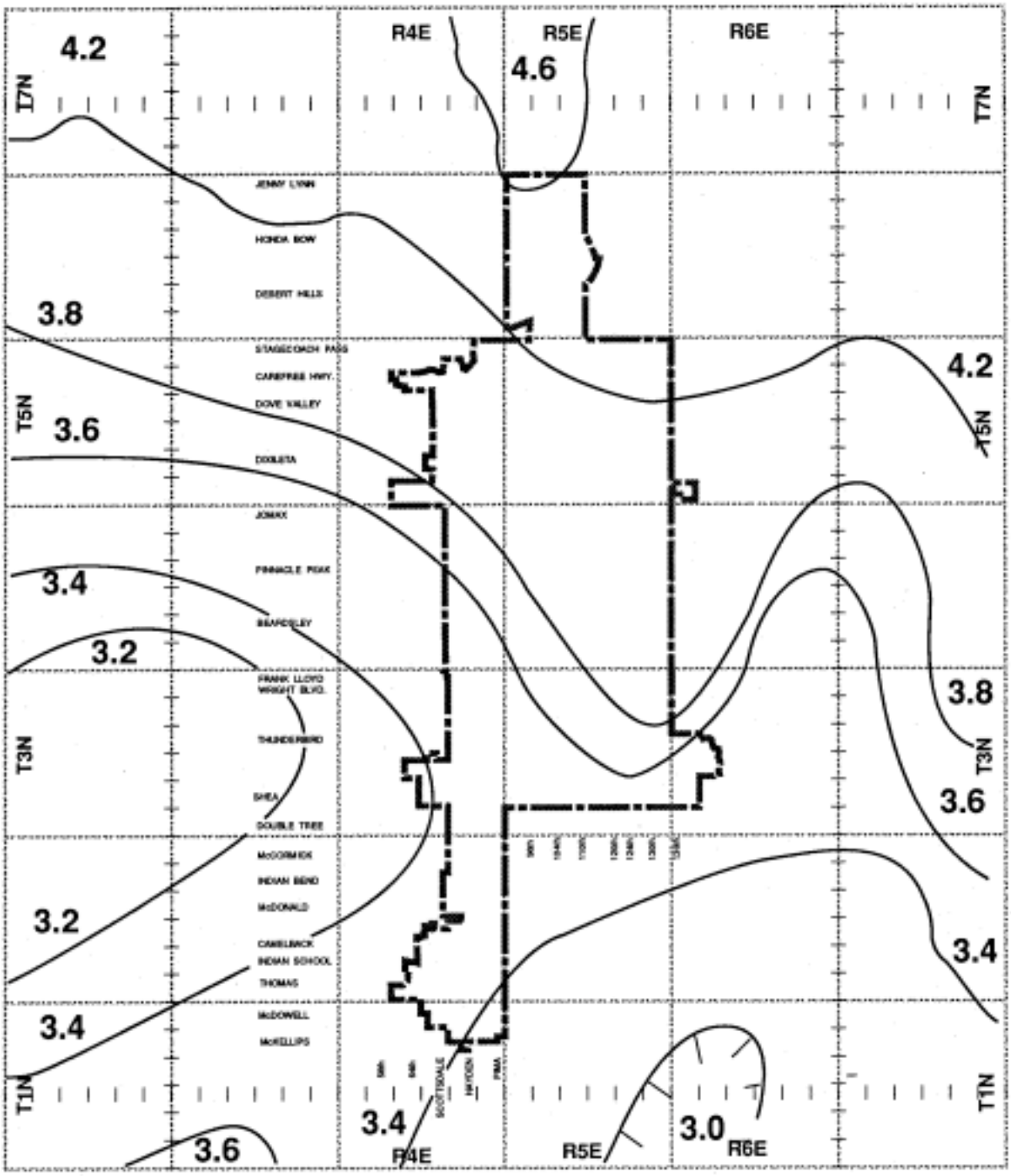


FIGURE 2.2-11

Isopluvials 50 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

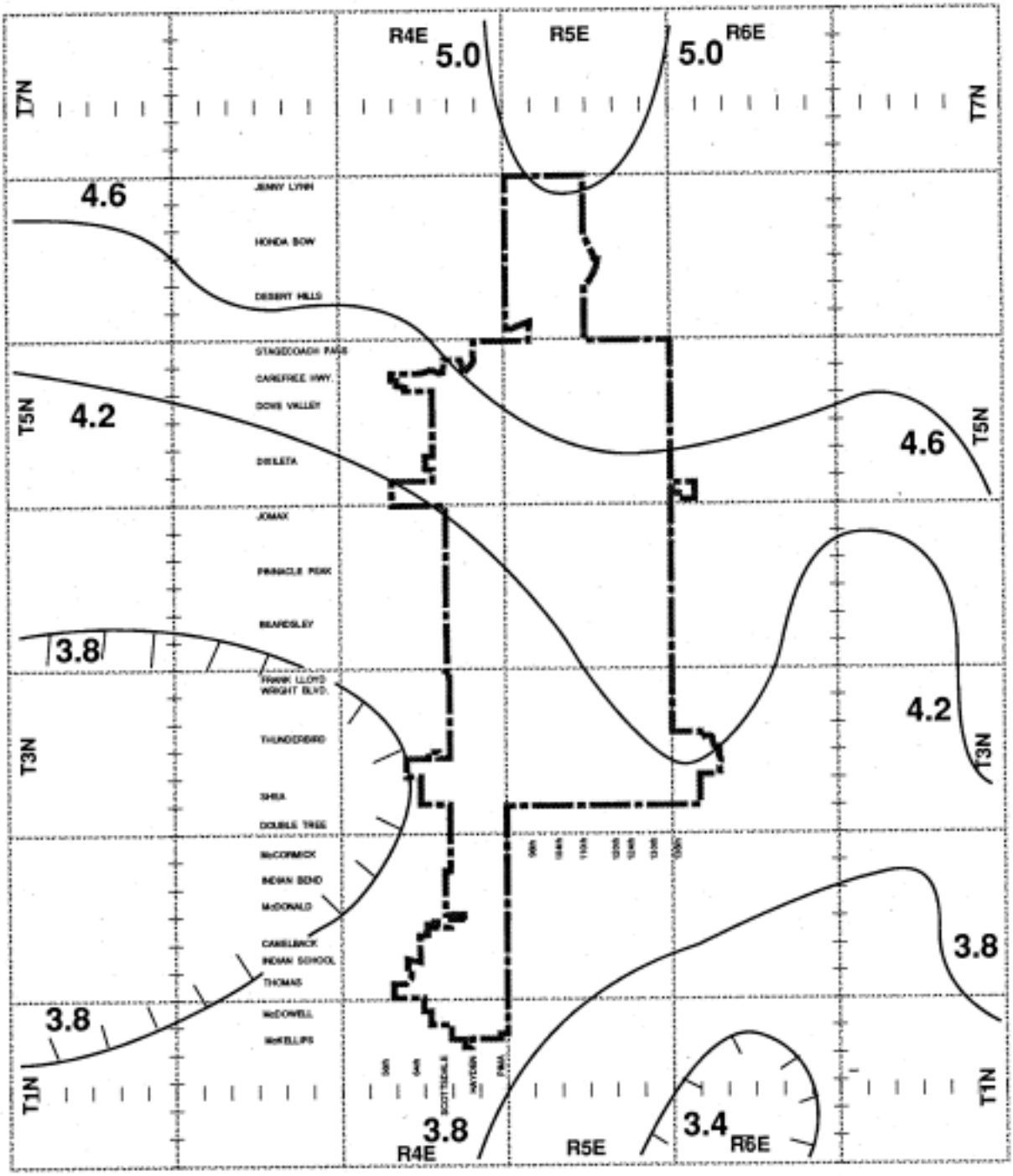


FIGURE 2.2-12

Isopluvials 100 Year 24 Hour Precipitation in Inches

Rainfall Data From NOAA Atlas 2, Vol. VIII

APPENDIX D

Miscellaneous Figures
Figures 2.2-13 through 2.2-21

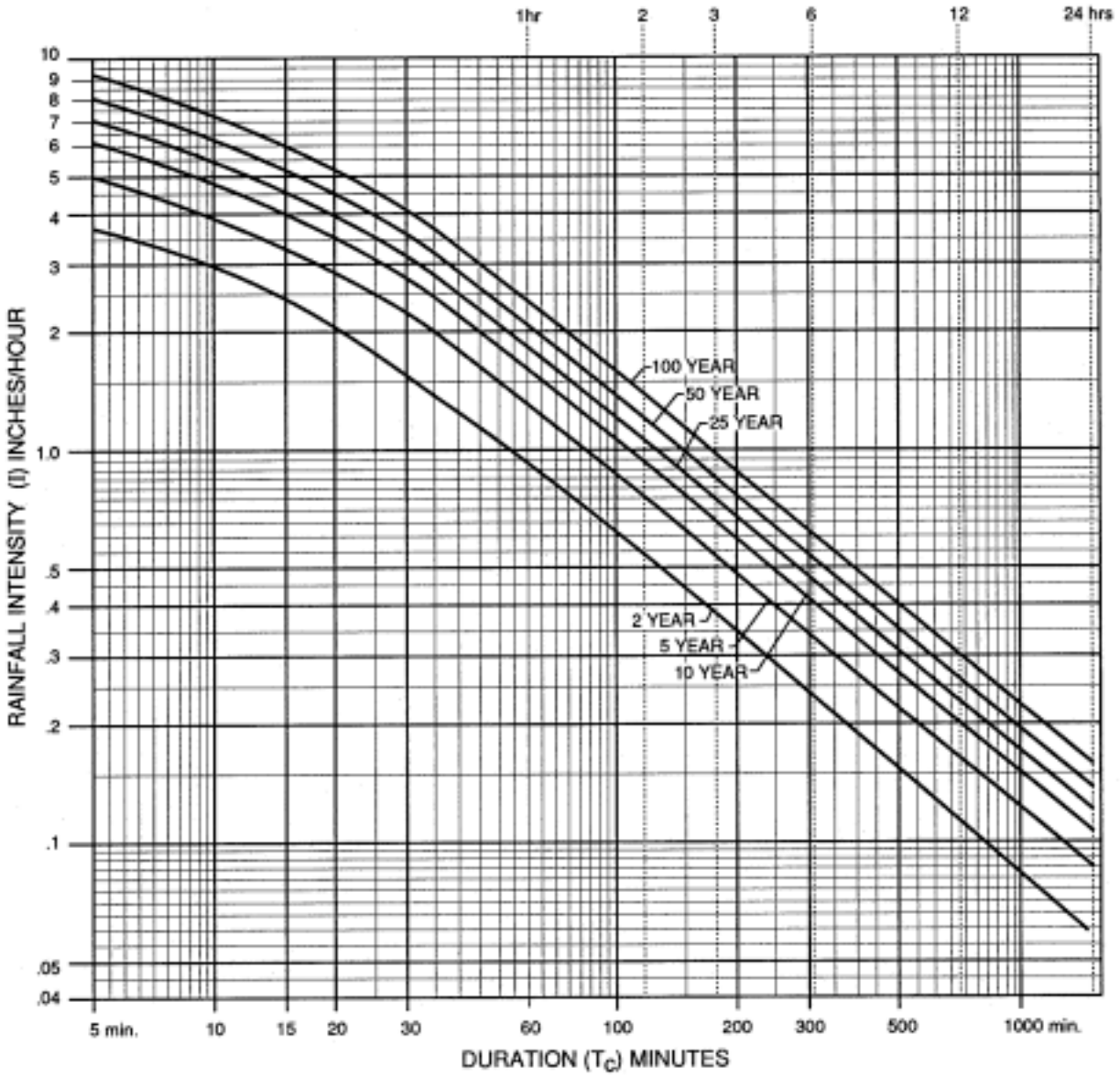
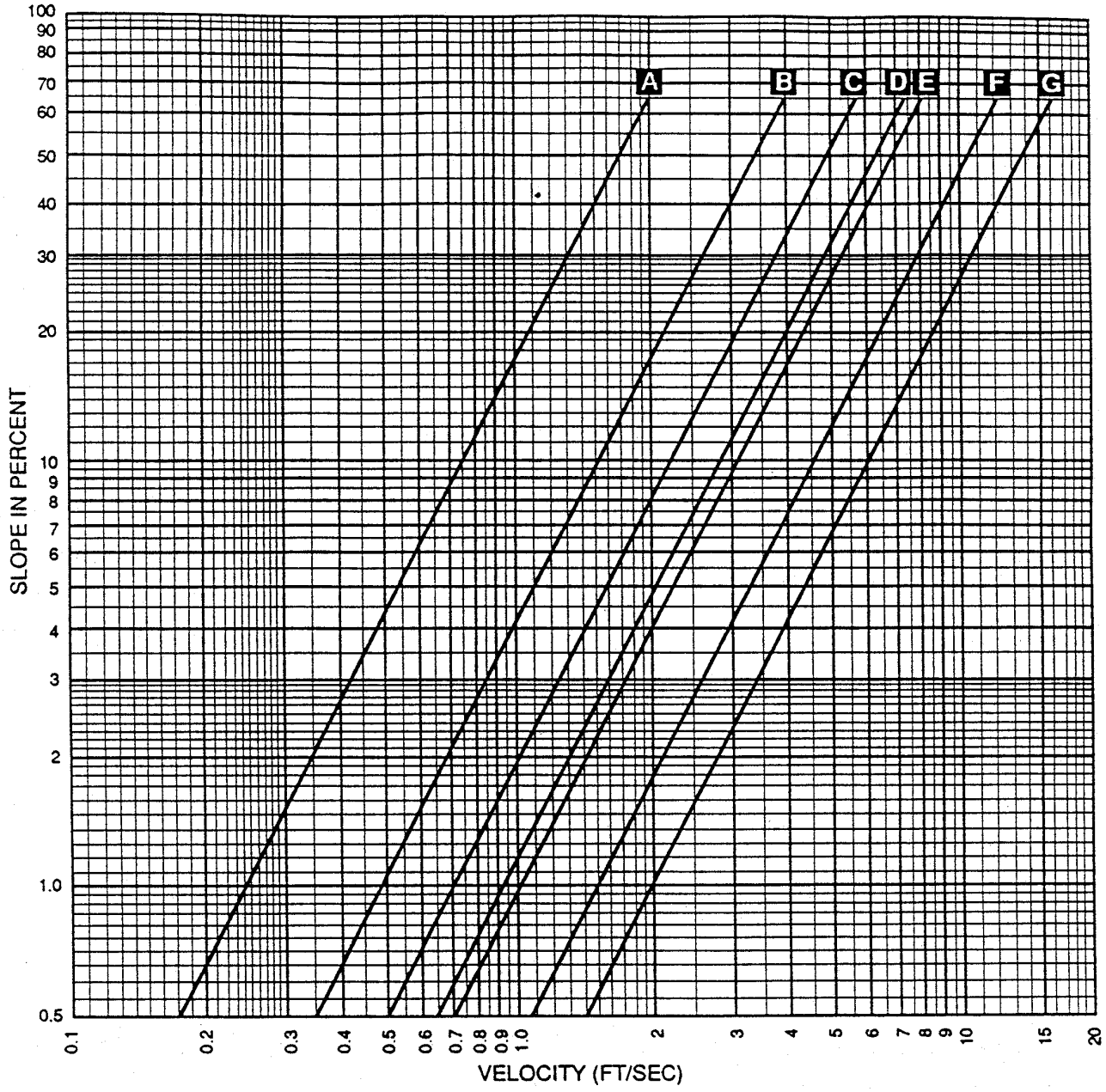


FIGURE 2.2-13

Rainfall Intensity (I) Values for Use in Rational Method

Source: Hydrologic Design Manual for Maricopa County



A Forest with heavy ground litter & hay meadow (overland flow)

B Trash fallow or minimum tillage cultivation; contour or strip cropped & woodland (overland flow)

C Short grass pasture (overland flow)

D Cultivated, straight row (overland flow)

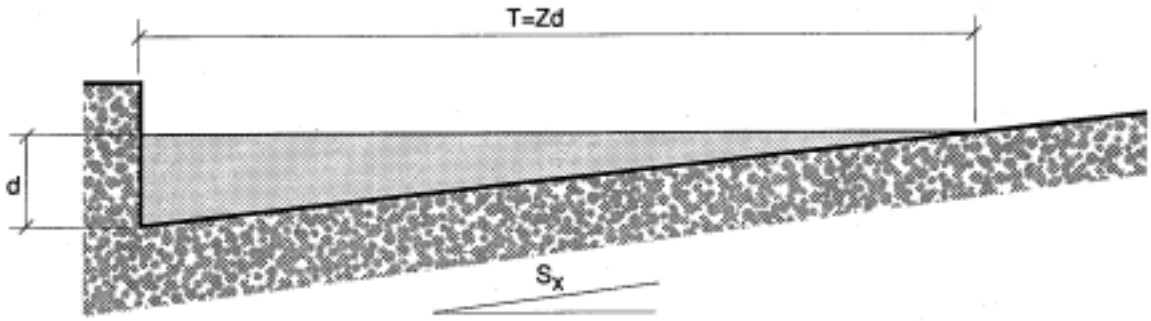
E Nearly bare and untilled (overland flow); alluvial fans western mountain regions

F Grassed waterway

G Paved area (sheet flow); small upland gullies

FIGURE 2.2-14

Overland Flow Velocities for Upland Method of Estimating T_C



$$Q=\left(\frac{0.56}{n}\right)S_x^{1.67}S^{0.5}T^{2.67}*$$

Where:

Q = Rate of discharge in cubic feet per second.

n = Manning's channel roughness coefficient.

S_x = Cross slope of gutter.

S = Longitudinal slope of gutter in feet per second.

T = Top width of water surface in feet.

d = depth of flow at curb in feet.

Z = Reciprocal of the cross slope T/d.

Since $V=Q/A$ and $A=\frac{Zd^2}{2}$:

$$V=\left(\frac{1.12}{n}\right)S^{0.5}d^{0.67}\ fps*$$

If n=0.013 (which is typical for concrete gutters):

$$V=\ 86\ S^{0.5}d^{0.67}*$$

If d=6" (0.5') when n=0.013:

$$V=\ 54\ S^{0.5}*$$

If d=4" (0.33') when n=0.013:

$$V=\ 41\ S^{0.5}*$$

*Does not apply when depth of water is above the top of curb

FIGURE 2.2-15

Flow Velocities in Street Gutters

(Source: Hydraulic Engineering Circular No. 12, U.S. Department of Transportation)

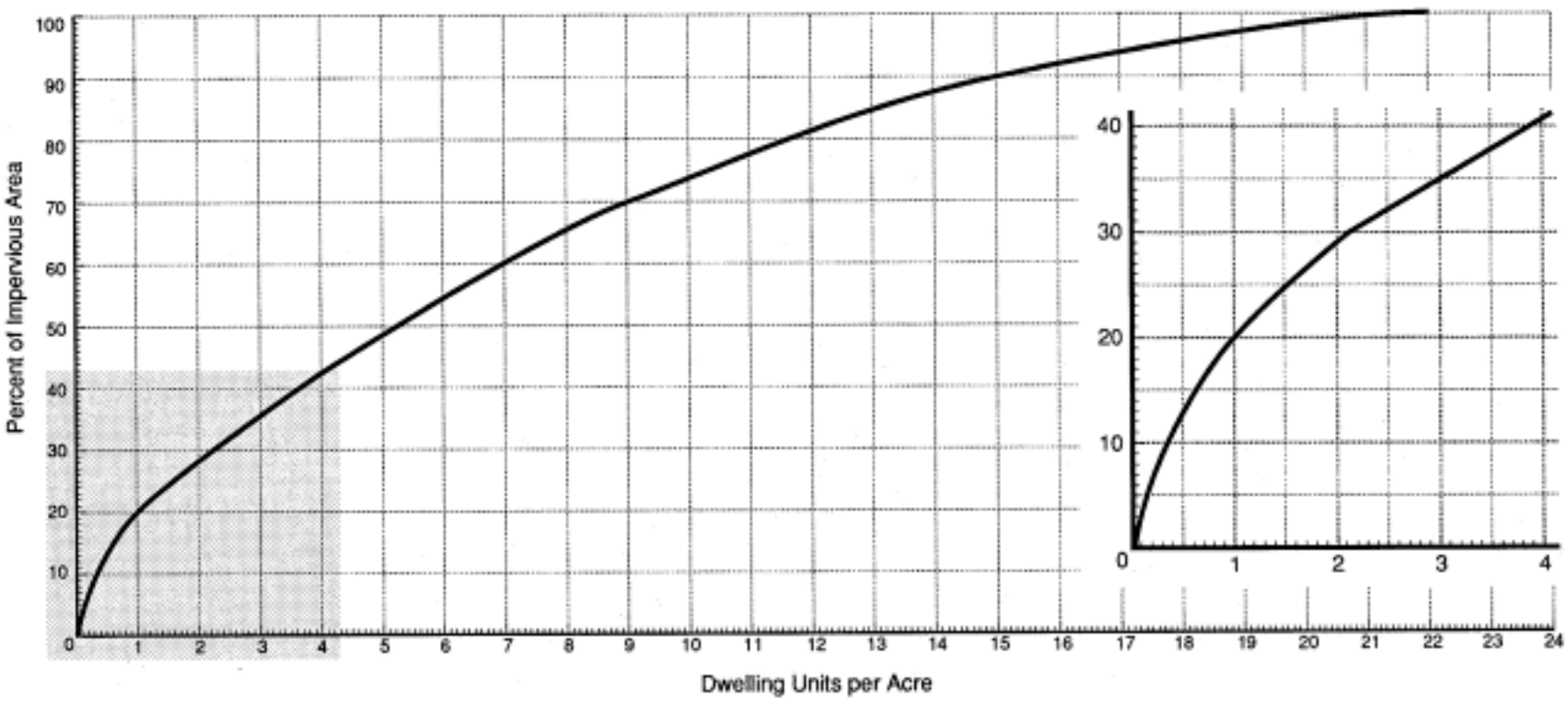


FIGURE 2.2-16

Percent of Impervious Area vs. Dwelling Density

Developed by Water Resources Associates, Inc. from data in Table 2.2a of TR-55, Urban Hydrology For Small Watersheds, and from discussions with Scottsdale city staff.

Runoff Coefficients

Land Use	"C" Value Hydrologic Soil Group B	C	D
Composite Area-wide Values			
Commercial and industrial areas:	0.90		
Residential areas-single family (average lot size):			
R1-1-190:	0.33	0.50	0.58
R1-130:	0.35	0.51	0.59
R1-70:	0.37	0.52	0.60
R1-43:	0.38	0.55	0.61
R1-35 (35,000 sq. ft./lot):	0.40	0.56	0.62
R1-18 (18,000 sq. ft./lot):	0.43	0.58	0.64
R1-10 (10,000 sq. ft./lot):	0.47	0.62	0.67
R1-7 (7,000 sq. ft./lot):	0.51	0.64	0.70
Townhouses (R-2, R-4):	0.63	0.74	0.78
Apartments and condominiums (R-3, R-5):	0.76	0.83	0.87
Specific Surface Type Values			
Paved streets or parking lot (concrete or asphalt), roofs, dirveways, etc.	0.95		
Lawns, golf courses, and parks (grassed areas):	0.33	0.56	0.66
Undisturbed natural desert or desert landscaping (no impervious weed barrier):	0.31	0.48	0.56
Desert landscaping (with impervious weed barrier)	0.83	0.83	0.83
Mountain terrain - slopes greater than 10%:	0.70	0.70	0.70
Agricultural areas (Flood Irrigated Fields):	0.20	0.20	0.20

FIGURE 2.2-17

Runoff Coefficients (C) for use with the Rational Formula

CITY OF SCOTTSDALE

HYDROLOGIC DESIGN DATA RECORD
RATIONAL METHOD

LOCATION DATA

PROJECT: _____ CONCENTRATION POINT: _____

LOCATION: _____

PROJECT NO.: _____ STATION: _____

NAME OF STREAM/WATERSHED: _____

DESIGN DATA

DESIGN FREQUENCY: | 2 | 5 | 10 | 25 | 50 | 100 | YEARS

DRAINAGE AREA:
- A1 _____ ACRES
- A2 _____ ACRES
- A3 _____ ACRES
- TOTAL (A) _____ ACRES

DRAINAGE LENGTH: _____ FEET

ELEVATION:
- TOP OF DRAINAGE AREA: _____ FEET
- AT STRUCTURE _____ FEET

DRAINAGE AREA SLOPE: _____ PERCENT

HYDROLOGIC SOIL GROUP: _____

DESIGN COMPUTATIONS

FREQUENCY FACTOR (F): | 1.00 | 1.00 | 1.00 | 1.10 | 1.20 | 1.25 |

TIME OF CONCENTRATION: T_c _____ MINUTES

RAINFALL INTENSITY (I): | | | | | | | INCHES/HOUR (Figure 2.2-13)

RUNOFF COEFFICIENT (C):
- C1 _____
- C2 _____
- C3 _____

WEIGHTED RUNOFF COEFFICIENT (C_w): C_w _____

PEAK DISCHARGE $Q_p = C_w IA(F)$: | | | | | | | cfs

COMPUTED BY: _____ DATE: _____

CHECKED BY: _____ DATE: _____

FIGURE 2.2-18
Hydrologic Design Data Record

Runoff Curve Numbers for Urban Areas[1]

Cover type and hydrologic condition	Average % Impervious Area[2]	Curve numbers for hydrologic soil group A	B	C	D
Fully developed urban areas with vegetation established					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover less that 50%)		68	79	86	89
Fair condition (grass cover 50-75%)		49	69	79	84
Good condition (grass cover greater than 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roads, driveways, etc. (excld. right-of-way)		98	98	98	98
Steets and roads:					
Paved; curbs and storm sewer (excld. right-of-way)		98	98	98	98
Paved; open dithces (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1 to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85				
Industrial	85				
Townhouse, duplexes	65	Not Applicable in Scottsdale			
Multi-Family	85				
Residential districts by average lot size: (See Figure 2.2-16)					
Developing Urban Areas					
Newly graded areas (pervious areas only, no vegetation)[5]:		77	86	91	94

[1]Average runoff condition, and I_a = 0.2S; Table 2-2a, 210-VI-TR55, Second Ed., June 1986.
[2]The average percent impervious area shown was used to develop the compsite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition (not applicable in Scottsdale).
[3]CN's shown are equaivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.
[4]Composite CN's for natural desert landscaping should be computed based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.
[5]Composite CN's to use for the design of temporary measures during grading and construction shoud be computed based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

FIGURE 2.2-19
Runoff Curve Numbers for Urban Areas[1]

Runoff Curve Numbers for Arid and Semiarid Rangelands[1]

Cover type and hydrologic condition	Hydrologic Condition[2]	Curve numbers for hydrologic soil group			
		A	B	C	D
Herbaceous - mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen - mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper - pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub - major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mequite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and $I_a = 0.2S$; Table 2-2d, 210-VI-TR55, Second Ed., June 1986.
[2]Poor: <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover (not applicable in Scottsdale)
Good: >70% ground cover (not applicable in Scottsdale).
[3]Curve Numbers for group A have been developed only for desert shrub.

FIGURE 2.2-20

Runoff Curve Numbers for Arid and Semiarid Rangelands[1]

CN for Condition II	CN for Condition I	CN for Condition III	CN for Condition II	CN for Condition I	CN for Condition III
100	100	100	54	34	73
99	97	100	53	33	72
98	94	99	52	32	71
97	91	99	51	31	70
96	89	99	50	31	70
95	87	98	49	30	69
94	85	98	48	29	68
93	83	98	47	28	67
92	81	97	46	27	66
91	81	97	45	26	65
90	78	96	44	25	64
89	76	96	43	25	63
88	75	95	42	24	62
87	73	95	41	23	61
86	72	94	40	22	60
85	70	94	39	21	59
84	68	93	38	21	58
83	67	93	37	20	57
82	66	92	36	19	56
81	64	92	35	18	55
80	63	91	34	18	54
79	62	91	33	17	53
78	60	90	32	16	52
77	59	89	31	16	51
76	58	89	30	15	50
75	57	88			
74	55	88	25	12	43
73	54	87	20	9	37
72	53	87	15	6	30
71	52	86	10	4	22
70	51	86	5	2	13
69	50	85	0	0	0
68	48	84			
67	47	84			
66	46	83			
65	45	82			
64	44	82			
63	43	81			
62	42	80			
61	41	79			
60	40	78			
59	39	78			
58	38	77			
57	37	76			
56	36	75			
55	35	75			

FIGURE 2.2-21

Curve Numbers (CN) for Antecedent Moisture Conditions I, II, and III

Section 2.3

HYDRAULICS
DESIGN STANDARDS AND POLICIES
REVISED DECEMBER 1999

CHAPTER 2
DRAINAGE

SECTION 2.3
HYDRAULICS

CONTENTS

SECTION 2.3
HYDRAULICS

2-301 INTRODUCTION

The design of drainage and flood control facilities in the city of Scottsdale shall meet the design criteria and guidance contained in the current Drainage Design Manual for Maricopa County, Volume II Hydraulics, (produced by the Flood Control District of Maricopa County) as supplemented by this manual section.

This manual contains additional clarifications or modifications specific to the design of facilities within the city of Scottsdale (COS). Specific COS requirements in the following subsections correspond to the appropriate chapter in the FCDMC Drainage Design Manual. (Example COS 2-30**2 Hydrology** corresponds to FCDMC's Chapter 2 Hydrology). Entries only exist in sections where supplemental guidance and or design criteria go beyond that contained in the FCDMC Manual.

2-302 HYDROLOGY

The determination of flood hydrology for designing stormwater facilities in the city of Scottsdale shall be performed according to the procedures set forth in the city of Scottsdale Design Standards and Policies Manual, Section 2.2. The following Table 2.3-1 outlines the minimum hydrology design criteria for stormwater management and drainage facilities within the city of Scottsdale. Facilities should not be designed using hydrology data from city master drainage plans developed for planning purposes. Hydrology data from any other source must be thoroughly reviewed and, as the design engineer, if you choose to use this data for design purposes you are accepting responsibility for any related liability that might result from its use.

Table 2.3-1 Hydrology Design Criteria *(italics represent citations from Floodplain and Drainage Ordinance)*

Drainage Feature	Peak Frequencies		
	10 Year	**50 Year**	**100 Year**
Street With Curb & Gutter	Runoff contained within street curbs. For collector and arterial streets one 12-foot dry driving lane must be maintained in each direction.	N/A	Runoff to be contained below the finished floor of building. *Runoff to be confined to road right of way or to drainage easements.* [37-42, (4)] *dmax=8 inches above the street.* [37-42, (4)]
Street Without Curb & Gutter (Dirt Roads, Ribbon Curbs)	Runoff contained within the roadside channels with the water surface elevation below the roadway pavement's subgrade.	N/A	Same as Street with Curb and Gutter.
Street with Storm Drain System	Pipes or roadside channels are added if the 10-year runoff exceeds street capacity.	N/A	Storm drains systems are used if 100-year runoff inundates the building's first floor. *Catch basins, scuppers, etc. to be provided to remove water so as not to exceed dmax =8".* [37-42, (4)]
Cross Road Culvert or Bridge for Major Collector & Arterial Streets	N/A	*Runoff to be conveyed by culvert or bridge under road with no flow overtopping the road*. [37-42, (3) a. 2]	*Runoff to be conveyed by culvert and by flow over the road with maximum 6-inch flow depth over the road.* [37-42, (3) a. 2]
Cross Road Culvert or Bridge for Local and Minor Collector Streets	*Runoff to be conveyed by culvert or bridge under road with no flow overtopping the road.* [37-42, (3)a.1]	*For a 25-year frequency storm runoff to be conveyed by culvert or bridge and by flow over the road with maximum 6-inch flow depth over the road.* [37-42, (3) a.1]	Maximum depth over road 12 inches.
Any street, watercourse crossing, that provides the only access to a residential area.	N/A	N/A	*All lots and structures must be accessible by at least one route with the depth of flow no greater than one foot during the 100-year runoff event*. [37-42, (3) a. 3]
FEMA Floodplain Channel (1)	N/A	N/A	100-year peak discharge
Open Channel for Offsite Flow Through Development	N/A	N/A	100-year peak discharge
Detention/ Retention Storage Basin	N/A	N/A	100-year 2-hour storm for determining on-site retention volume

2-303 STREET DRAINAGE

A. Design Criteria for Streets and Gutters

1. Pavement Encroachment
   Typical street sections used in city of Scottsdale are shown in Section 3.1, Geometrics, of the city's Design Standards and Policies Manual. See Figures 3.1-2 through 3.1-7, in Section 3.1.

2. Theoretical Capacity
   A Manning's "n" value of 0.015 (normal asphalt) or 0.016 (rough asphalt) shall be used for street flow unless special conditions exist which must be clearly documented in the Drainage Design Report.

3. Longitudinal Street Grades
   The desirable minimum longitudinal street grade is 0.4% to ensure that the gutters will function properly. Whenever possible, longitudinal street grades greater than or equal to this minimum shall be provided. It is recognized that this desirable grade is not always attainable, particularly with projects involving existing streets. In such situations, the absolute minimum longitudinal street grade is 0.2%.

   From an environmental standpoint, maximum street grades should not exceed 10%. Additionally, when planning street grades, emergency vehicle access needs to be considered in the design. Any slope less than 0.4% or greater than 10% needs specific review and approval by city staff.

B. Design Criteria for Intersections
   Valley Gutters: are permitted to transport runoff across local streets when a storm drain system is not required. However, valley gutters are generally not acceptable across collector or arterial streets. In unusual cases, valley gutters may be necessary in order to move street drainage across a Collector Street. In such situations, the valley gutter shall be a minimum of eight feet in width in order to lessen the impact on traffic.

C. Design Criteria for Roadside Ditches
   Non-Raised Curb Streets (ribbon curbs, dirt roads): The purpose of roadside ditches is to collect intercepted overland flow, cut slope runoff, and pavement runoff, but not concentrated offsite flow. For any street that does not have a raised curb, a minimum six inch deep V-shaped grader ditch shall be installed on both sides of the street at the edge of the road shoulder; unless it can be demonstrated and is documented in the project drainage report why the ditches are not necessary. An exception requires specific city staff approval. Roadside ditches must be shown on plan sheets (arrows in the direction of flow) as well as on cross section details. See typical cross section in Figure 2.3-3.

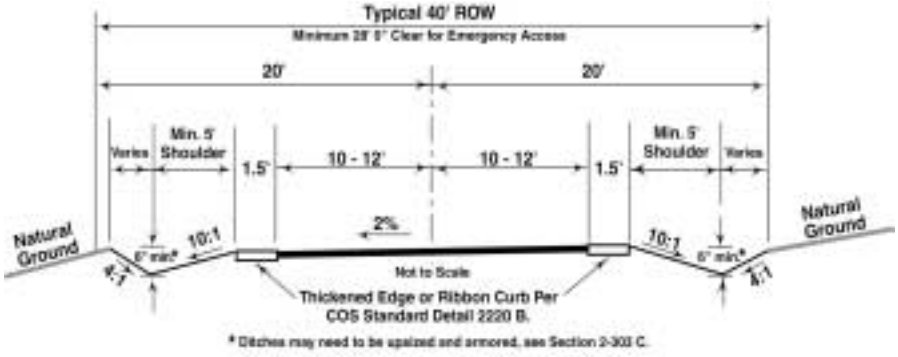


Fig. 2.3-3 Typical Cross Section for Roadside Ditches for Non-Raised Curb Street with Crown or Straight Cross Slope

Ditches must intercept and safely convey flow to the nearest recognized watercourse. If more than normal sheet flow runoff from the road cross section or cut slopes is intercepted or accumulated in the roadside ditches before it can be safely discharged then the ditches need to actually be sized. If velocities exceed 4-5 feet per second, then appropriate erosion or scour protection must be provided. Ditches are necessary to prevent runoff and debris from washing onto the roadway to prevent erosion of roadside areas adjacent to the edge of pavement or curbing; and to prevent runoff from the road surface flowing into front yards, driveways, garages, and homes.

D. Catch Basins

1. **Grated Catch Basins:** MAG, ADOT, and City of Phoenix catch basin details are acceptable if modified to be “bicycle friendly” (wheel can’t drop into space between bars on the grates).
2. **Scuppers:** MAG Standard Detail 206 shall be used as basis of scupper design unless prior approval of another design is obtained from city staff.
3. **Slotted Drains:** The use of slotted drains for shallow sheet flow conditions is permitted in the city of Scottsdale. Slotted drains may also be used in other situations with city staff approval.

2-304 STORM DRAINS

A. Separation of Storm Drain Systems from Water and Sewer Lines
Horizontal separation of storm drains and water or sewer lines shall be a minimum of 6 feet. Vertical separation of storm drains and sanitary sewers should be 2 feet (sanitary sewer below) unless the sewer line is manufactured from ductile iron with mechanical joints or equal. Concrete encasement may also be required by the city Water Resources Department. Vertical separation of storm drain and water line (water line below) shall be 3 feet clear. Separation is measured from the outside of the two pipes.

B. Sizing
The minimum pipe size of a storm drain lateral shall be 18 inches. In situations where debris may be expected, the city’s Drainage Planning staff should be consulted for applicable debris criteria.

C. Natural Watercourses
Washes and even man-made channels carry a continuous supply of sediment and debris. It is almost impossible to collect and filter out this debris without a constant clogging and maintenance problem.

1. In the ESL area, intercepting a natural wash with a capacity of 50 cfs or greater, with the intent of collecting it and directing it into a pipe or an underground storm sewer system is prohibited by ordinance.

2. In all other areas of the city, avoid, if possible, the interception of an off-site natural wash with the intent of collecting it and putting it into a pipe or an underground storm sewer system.

3. If there is no alternative to the routing of an open channel into a piped system, water should be first routed into a sediment or debris basin. Periodic maintenance of the debris basin will be required and responsibility clearly assigned to the HOA on the plat, grading and drainage plan, and in the drainage report. The capacity of the conduit should be 100 percent of the design discharge plus 30 percent to accommodate any sediment and debris.

2-305 CULVERTS AND BRIDGES

A. Inverted Siphons
Inverted siphons shall only be used when no other solution is available. City staff approval is required.

B. Culvert Profile
If a culvert is placed more than 0.5 feet below the natural wash invert, the capacity of the culvert must be reduced by the cross section area below this depth.

C. Private Bridges and Culvert Crossings
It is recommended that homemade drainage structures be restricted to crossing small channels whose source originates onsite (on-lot). The homeowner should use either dip crossings or free span bridges that do not constrict the flow capacity of the channel. Homemade drainage structures are discouraged and can be disastrous for the homeowner, neighbors, and adjacent streets. If undersized or installed improperly culverts can create a backwater into adjacent homes or property; cause a diversion of flow; or cause excessive scour and erosion. See Section 2.1, Figure 2.1-2 for proper installation. A minimum pipe size of 15 inches is recommended to avoid clogging or plugging.

Professional advice is always recommended. However, when attempting to cross a larger wash whose source originates off-site, a registered civil engineer should be consulted.

2-306 OPEN CHANNELS

A. General
Open channels are defined as watercourses which may be natural or manmade (artificial). Natural washes or streams generally have an active low flow channel and an adjacent floodplain. For purposes of these guidelines the open channel or watercourse is assumed to include the entire area needed to convey the entire100-year flood, its channel and floodplain. Construction of any kind within a within a dedicated drainage easement requires a City Encroachment Permit.

The city of Scottsdale is a member of the National Flood Insurance Program and must administer floodplain use in accordance with the federal program (FEMA) requirements. Within the city of Scottsdale, County Floodplain use permits or drainage permits are not required. In Scottsdale, floodplains and drainageways, including FEMA designated floodplains, are regulated through site development plan requirements. This is done as part of the standard building permits application process or by a right-of-way Encroachment Permit.

B. Floodplains

In Environmentally Sensitive Land (ESL) areas, the 100-year floodplain shall be delineated for watercourses having a capacity of 50 cfs or greater. In all other parts of the city, the 100 year floodplain shall be delineated for all watercourses having a capacity of 25 cubic feet per second (cfs) or greater (COS Ordinance Sec. 37-42.(2)). Delineated floodplain limits shall be clearly shown on all site development plans.

C. Drainage Easements

1. Encroachment Permits are required to enter and use any portion of a designated drainage easement.

2. Drainage easements must be dedicated to the city to the extent of the 100-year floodplain for all watercourses having: 50 cubic feet per second (cfs) capacity or greater in ESL areas; and 25 cfs or greater throughout the rest of the city; and for any watercourse with a peak discharge of 50 cfs or greater for the 100 year flood event.

3. Maintenance of drainage easements is generally the responsibility of the individual property owner or Homeowner's Association. Maintenance responsibilities must be clearly recorded on the Final Plat and noted on the Grading and Drainage Plan.

4. Any modification or proposed abandonment of a drainage easement needs specific advanced review and approval by city staff per the easement release procedures described in Section 2.1, 2-102 A. 3.

D. Artificial Channels

1. Unlined Earthen Channels

   a. In general, the maximum permissible velocity for channel design south of the Central Arizona Project Canal (CAP) is 5.0 fps.

   b. In general, the maximum permissible velocity north of the CAP is 4.0 fps.

   c. Vegetation growth or artificial revegetation must be incorporated into the design through either a reduction in the cross sectional area of the channel and/or an increase in the roughness coefficient. Any vegetation growth that reduces the design flow capacity of the wash shall be removed through routine maintenance.

2. Lined Channels

   a. The design flow capacity of the wash or channel must not be reduced by the placement of lining or landscaping material, including revegetation. The material must be inlaid or located below the design invert (bottom) of the channel. Do not place material on top of the designed finished grade of the channel cross section.

The design of the channel must include any embelishments that will reduce the carrying capacity.

b. The channel surface material (roughness coefficient) or cross sectional area may not be changed without a plan revision and re-approval by city staff.

c. If only the channel banks are being lined, the lining material must extend down a minimum of 3 feet below the channel invert or to the calculated scour depth.

3. Channel Alignment

a. Avoid designing turns in open channels greater than 45 degrees. If curves or bends can't be avoided the "run-up" on the outside of curves must be calculated and incorporated into the channel's design freeboard.

b. Channels should be located a separate drainage tract whenever possible. Avoid designing channels in a location that goes from back yard to back yard, unless outside of recorded building envelopes which prohibit the channel from being walled in.

c. Channels through walled in lots, commonly catch debris, and clog, and homeowners often block these openings. It is difficult if not impossible to inspect or insure these channels are properly maintained.

d. Lot lines should end at the edge of the wash floodplain, or man-made channel, not in the middle or on the other side.

e. Building envelopes are not recommended as a substitute for drainage easements. They can help but are too often misunderstood or ignored as a limit to construction of walls or structures.

E. Scour Analysis

Acceptable procedures for the estimation of channel degradation depth are described in Guideline 1 of State Standard 5-96, dated September 1996, published by the Arizona Department of Water Resources (ADWR), Flood Warning and Dam Safety Section. Copies can be obtained from ADWR or the city's Drainage and Floodplain Management staff.

Three levels of analysis are provided within the Guideline. Level I analysis provides an acceptable estimate of the potential scour depth for the design of structures placed near a streambed or along the banks of a channel, for channel reaches that are in general balance with the surrounding system--i.e. no major disturbances (dams, bridges, encroachments, etc.) evident in the vicinity—and where the desire is to establish a "safe" scour depth that can naturally occur within channels composed of erodible material.

Level I analysis requires only the peak discharge for the 100-year flood to estimate total scour depth. **When a Level I analysis is used, the required minimum total scour depth is 3 feet.** If Level I conditions exist and the 100 year peak discharge is 500 cfs or less no calculations are required if the 3 foot scour depth is used. Calculations are required for flows greater than 500 cfs.

Level II or Level III analyses are required when Level I conditions do not exist, or less than 3 feet of scour protection is proposed. These levels are more detailed for more site

specific erosion limits, which require local hydraulic information and sediment size distributions or historical data.

F. Maintenance

1. **Access:** Reasonable access for maintenance should be provided in order to properly maintain open channels. Minimum width of access should be 8 feet. Spacing between vehicular access points should be a maximum of ½ mile, although ¼ mile spacing is preferable. A minimum of one access point per subdivision is required. Non-vehicular access points shall be provided every 660-foot maximum. If the facility is to be city maintained the above minimum requirements are mandatory.

2. **Responsible Party:** Maintenance of drainage facilities within the city of Scottsdale is usually the responsibility of the property owner or the Subdivision's Homeowners Association. Specific maintenance responsibilities should be part of the dedication on the Recorded Plat and noted on the Grading and Drainage Plan.

G. Safety
The city of Scottsdale requires fencing (railing) at vertical drops of two feet or greater around an inlet or outlet works. Access for maintenance should be maintained to the extent practicable.

2-307 HYDRAULIC STRUCTURES (RESERVED)

2-308 DETENTION AND RETENTION FACILITIES (STORMWATER STORAGE FACILITIES)

A. Interaction with other Components of a Drainage System

1. Waiver Requests
The cumulative effects on the entire upstream as well as the downstream watershed must be evaluated. Do not assume storage can be waived just because an area is small relative to the entire watershed or because the project is at the very downstream end of the watershed. These are common arguments for waivers; however they are only valid if the remainder of the watershed is already developed, and if downstream receiving channels and or storage facilities have adequate capacity. If not, the cumulative effects of waiving storage on many small individual projects within the same watershed can result in major downstream flooding problems.

2. Design Criteria
Development must store runoff from rainfall events up to and including the one hundred-year, two-hour duration event. Multi-frequency storm control must be incorporated into basin design. Rainfall runoff from storms of all frequencies should enter and depart from property in substantially the same manner as under pre-development conditions (COS Sec: 37-42). As a minimum the 2, 10, and 100-year events should be analyzed.

B. Hydrology
The Uniform Drainage Policies and Standards for Maricopa County, Arizona (February 25, 1987), states that: "all development shall make provisions to retain the peak flow and volume of runoff from rainfall events up to and including the 100 year, 2-hour duration storm falling within the boundaries of the proposed development". The procedure for determining the volume of runoff from the 2-hour storm is provided in Section 2.2 Hydrology, Chapter 2-204 of The City of Scottsdale Design Standards and Policies Manual. See Section 2.1 for additional guidance.

C. Basin Location

1. On-line basins are generally prohibited unless specific advance approval is obtained from both city project review staff and the city's Floodplain Administrator.

2. Off-site washes shall be routed around and not through stormwater storage basins, whenever possible.

3. Maintenance must be planned for and responsibilities must be clearly stated on the recorded plat and grading and drainage plan if an online basin is permitted or if off-site flows are routed into a storage facility.

4. All storage facilities must have an emergency spillway or overflow point that will safely discharge to a recognized watercourse.

5. On-lot storage on individual single family residential lots is generally prohibited and should not be used as a solution to meet overall subdivision storage requirements. Storage facilities shall be located within a common area tract or drainage easement dedicated to the city, and must have maintenance access from a public right of way.

D. Detention/Retention (Storage) Facility Inlet and Outlet Structures

1. Methods for Draining Stormwater Storage Facilities
   Storage facilities should be drained by positive gravity outlet. The minimum allowable pipe size for primary outlet structures is 18 inches. Water must be discharged into a recognized natural watercourse, open channel, or into a nearby storm sewer system. If discharged into a storm sewer system the maximum discharge is 1 cfs and water should be discharged directly into a catch basin or other inlet.

   Water cannot be discharged into a City Street, gutter or alley without specific prior approval of city staff. Water shall only be allowed to be discharged into a city street, if its flow is no more than 1 cfs and it can be conveyed safely via a gutter or roadside ditch to a storm sewer inlet or recognized watercourse, without flowing across a city street or intersection.

   Methods for draining facilities are listed in the following order of preference:

   a. Positive Gravity Outlet

   b. Pump Station

   c. Dry Wells
      Dry wells are only permitted as a last resort and need prior city staff approval. Dry wells are not appropriate for use in flow-through systems or in facilities receiving offsite flow. Dry wells must be designed per FCDMC Design Manual Vol. III design requirements.

   d. Natural Infiltration (Basin Floors)
      Designing a basin to drain solely by natural infiltration through the bottom of the basin is prohibited. Basin floor infiltration is not dependable. The soil characteristics that accurately reflect conditions of the finished basin are difficult to analyze and basins are not properly maintained to retain their infiltration capacity.

2. Drain Time
   All storage facilities should be designed such that the stored runoff shall be discharged completely from the facility within 36 hours following the storm event. This is a city Ordinance requirement related to Maricopa County Health Department Standards. Drain time must be engineered to ensure the effectiveness of the basin and should not be designed to drain in less than 24 hours. An orifice plate over the minimum size pipe may be used to control the outflow rate.

3. Parking Lot Storage
   Up to 50% of the required storage volume may be provided in parking areas if the following conditions are met:

   a. Storage system shall store the first 30% of the required runoff volume off paved areas (to avoid nuisance water constantly ponding on the pavement).

   b. Interference with pedestrian traffic must be minimized in the design of the storage facility.

   b. Depth of water shall not exceed six inches within the parking area.

4. Embankment Design Criteria
   Embankments are small dams that can be a serious potential downstream flood hazard. Detention or Retention facilities should be constructed below the natural ground surface whenever possible. The only above ground storage allowed is that created behind a designed road fill. The use of any other embankment to impound Stormwater runoff requires specific prior approval by city staff. If approval is obtained, all the design requirements contained in the FCDMC Manual Sec. 8.3.3 must be completely and thoroughly followed. In addition, except for designed road fill, the owner/developer must provide the city as-built certification by a registered Geotechnical or Civil Engineer, experienced in dam technology, that the embankment was designed, and constructed properly, is stable, and will safely impound the design volumes of water.

5. Underground Storage (Reserved)

E. Operation and Maintenance
   Maintenance of storage facilities within the city of Scottsdale is usually the responsibility of the property owner or the Subdivision's Homeowners Association.
   Specific maintenance responsibilities shall be clearly indicated on the recorded Final Plat and noted on the Grading and Drainage Plan.

F. Volume Certification
   The property owner will provide the city with certified as-built dimensions of the basins and the actual volume of storage provided. Either a civil engineer or land surveyor who is registered to practice in the State of Arizona must base this on "as-built" topographic surveys. The as-built volumes must reflect permanent finished landscaping in place. The volumes shall be certified by the Design Engineer that the volumes provided meet or exceed the required design volumes per COS Ordinance and the approved Drainage Plan. The volume of storage provided must equal or exceed the approved design volumes before the city will issue Letters of Acceptance for maintenance of any public facilities.

2-309 PUMP STATIONS (RESERVED)